The Laguna Plata Site Revisited: Current Testing and Analysis of New and Existing Assemblages at LA 5148, Lea County, New Mexico

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THE LAGUNA PLATA SITE REVISITED: CURRENT TESTING AND ANALYSIS OF NEW AND EXISTING ASSEMBLAGES AT LA 5148, LEA COUNTY, NEW MEXICO

[redacted]

By

TRC Environmental

Austin, Texas ■ Albuquerque, New Mexico ■ El Paso, Texas

December 2010

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Abstract

TRC Environmental, Inc., Albuquerque, New Mexico under contract with the Bureau of Land Management, Carlsbad Field Office, carried out the required archaeological and geomorphologic investigations at LA 5148, Lea County, New Mexico, as well as an analysis of existing artifact collections from the same site. Under the Bureau of Land Management's Permian Basin Mitigation Program, TRC carried out Task Order 05 with the goal of providing a more comprehensive interpretative assessment of prehistoric use at LA 5148. Based on the significance of the sites reported in the vicinity, the area surrounding LA 5148 was designated a National Register Archaeological District in 1989 and added to the State Register in 1990 (HPD#1520). Positioned along the western margin of the Laguna Plata basin, LA 5148 is within the greater Laguna Plata Archaeological District, Lea County, New Mexico.

This proposed project fulfilled the responsibilities mandated under the Scope-of-Work issued on January 26, 2010 and awarded March 3, 2010. For this mitigation project, TRC documented cultural materials, and recovered significant archaeological data from the selected prehistoric site. Task Order 05 was conducted in accordance with the National Historic Preservation Act (NHPA), 36 CFR 800, and other relevant laws, regulations, standards, and guidelines and provides a critical tool in the future management of archaeological resources contained within this site. Subsequently, this information will contribute to the Bureau of Land Management's Land Study and provide a valuable tool in the future management of federally owned lands within southeastern New Mexico.

The testing process carried out at LA 5148 consisted of a phased testing strategy that included site survey and documentation, geophysical survey, geoarchaeological testing, test excavations, and a 25-acre survey. The fieldwork commenced on April 20, 2010 and ended on April 27, 2010. The final site check was conducted on October 22, 2010. The results of each phase contributing to the subsequent one. Phase I documented the site through the point provenience of artifacts and features, identification of the LCAS datum, re-establishing the LCAS excavation grid and test units, and documenting the current site boundary. At the end of the first phase, a geophysical survey of the C-10-C locus and two additional survey blocks immediately north of the two-track access road was carried out. The geophysical survey employed three techniques: 1) ground penetrating radar with a 250 MHz radar, 2) magnetometer survey with a Geometrics G-858 cesium vapor magnetometer, and 3) ground conductivity profiler. The geo-referenced grid covered a 25 m x 20 m area that encompassed the primary LCAS excavation area (Runyan 1971). Anomalies identified on and near the presumed LCAS test units strengthened the data derived from the LCAS documentation (Runyan 1971). Geoarchaeological testing and evaluation followed immediately after the geophysical survey. Manual excavations of the LCAS 15-ft x 15-ft test units were conducted concurrent with the geoarchaeological testing with constant collaboration between the two groups. The fourth phase consisted of mechanical trenching of areas significant to understanding the geomorphology and contextual composite of the site and its environs. The final phase of the project included the pedestrian survey of 25 acres adjacent to LA 5148.

Forty-three features were documented, the majority of which were identified during the site survey phase (Phase I). Phase III of the testing strategy focused on the hand excavation of Features 2 and 3 identified by Runyan (1971) as irregular-shaped pithouses. The site survey identified Feature 6 exposed in an east-west trending arroyo cut. The subsurface testing phase resulted in 41.5 m² of manual excavation. Phase IV consisted of 80 m² of backhoe trenching involving eight linear trenches.

Phase V consisted of a pedestrian survey of five 5-acre parcels. Parcel 1 was immediately northeast of the C-10-C locus, just north of the site boundary. Parcels 2 and 3 were combined to form a 10-acre rectangle. This parcel was within and outside of the west-central portion of the site. Parcels 4 and 5 were placed

along the southeastern margin of the basin in an effort to identify the soil deposits associated with the spring activity and assess the depositional history of this portion of the basin interior.

The final phase of the project consisted of artifact analysis. During this project 9,006 artifacts were analyzed (n=8,974 LCAS, n=32 TRC). Five macrofloral and five pollen samples were processed; seven artifacts were subjected for starch pollen analysis; and seven artifacts were submitted for FTIR residue analysis. Nine radiocarbon samples were collected from the interior of excavated features, or from organic lenses identified in the backhoe trenches, and submitted for radiocarbon analysis. Eight samples were submitted for diatom analysis; six obsidian flakes were submitted for XRF analysis; and ten ceramic sherds were submitted for INAA analysis. Of the feature-related radiocarbon samples submitted, Feature 2 yielded a conventional age of 1740±25 B.P. and Feature 3 yielded conventional ages of 870±28 B.P. and 900±25 B.P. from Posts A and C, respectively. Combined with the diagnostic artifacts, three periods of increased site use are identified at LA 5148: 1) A.D. 200/400–1100, 2) A.D.1100–1300, and 3) A.D. 1300–1450. These age brackets are thought to reflect activities oriented around seasonal site use and potential targeting of this specific landform during the Formative period.

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1.0 Introduction

Peter C. Condon

1.1 Project Description

This report presents the results of the documentation, limited testing at LA 5148, as well as the typological, and attribute level of analysis carried out on existing Lea County Archaeological Society (LCAS) artifact collections recovered from the site. Performed on behalf of the Bureau of Land Management (BLM), Carlsbad Field Office, Eddy County, New Mexico, under the BLM's Permian Basin Mitigation Program, Task Order 05 was carried out under Archaeological Resource Protection Act (ARPA) permit 45-8152-10-30 and BLM survey permit 45-2920-09-TT with the goal of providing a more comprehensive interpretative assessment of prehistoric use at LA 5148. Based on the significance of the sites reported in the vicinity, the area surrounding LA 5148 was designated a National Register Archaeological District in 1989 (NRHP #89001209)and added to the State Register in 1990 (HPD#1520). Positioned along the western margin of the Laguna Plata basin, LA 5148 is within the greater Laguna Plata Archaeological District, Lea County, New Mexico (Figure 1.1).

This proposed project fulfilled the responsibilities mandated under the Task Order 4 Scope of work issued on January 26, 2010 and awarded March 3, 2010. Because of this project, cultural materials were documented and archaeological data were recovered from the site. Task Order 4 was conducted in accordance with the National Historic Preservation Act (NHPA), 36 CFR 800, and other relevant laws (ARPA permit 45-8152-10-30), regulations, standards, and guidelines and provides a critical tool in the future management of archaeological resources contained within the site. Subsequently, this information will contribute to the BLM's Land Study and provide a valuable tool in the future management of federally owned lands in southeastern New Mexico.

1.2 Site Location

[redacted] Laguna Tonto, Laguna Gatuna, Laguna Tolston, and the largest playa, Laguna Plata, comprise a series of once interconnected depressions that demarcate this unique environmental landscape (Laumbach et al. 1979). The Laguna Plata playa is about a 1.5 x 0.75 mile basin within the Mescalero pediment, Pecos Valley section of the Great Plains physiographic province (Fenneman 1931).

Several cultural resource management projects have been undertaken in the project area in response to ongoing oil and gas development. Between 1971 and 2004, a minimum of 11 undertakings have been associated with the Laguna Plata Archaeological District. Archaeological sites encountered during this period were mapped on USGS topographical maps, inventoried using a variety of field methods, and documented on standardized Laboratory of Anthropology (LA) site forms.

Subsequent site recording and documentation focused on defining the site boundary and evaluating LA 5148 and other sites for contextual integrity and NRHP eligibility. A variety of survey strategies were used to define the site boundary; however, the horizontal distribution of discernible cultural material appears to be the critical factor in establishing the spatial context at LA 5148. Artifact collections primarily targeted diagnostic artifacts, but also included discernible lithic tools on the surface. Collected artifacts are curated at the New Mexico Laboratory of Anthropology in Santa Fe, New Mexico. Additional documentation is archived at Eastern New Mexico University, Portales, New Mexico.

[redacted]

1.3 Environmental Setting

Physiographically, the Laguna Plata site is within the Mexican Highland portion of the Basin-and-Range province of the western United States (Fenneman 1931). The Laguna Plata site is along the eastern boundary of the Mescalero Plain about 56.32 km (35 mi) east of the Pecos River. Laguna Plata was formed as a collapsed basin within the Mescalero Plain that is hydrologically active through spring discharge and as a catchment during seasonal rainfall. The environment south of the basin is characterized by shallow deflation basins, eroded dunes, and relatively flat terrain accentuated by mesquite, creosote, and grasses. North and west of the basin, the environment consists of active dune development, deflation basins, and sediment accumulation stabilized by coppice and parabolic dunes. East of the basin, the topography is relatively flat, with small playas interspersed by localized dune development.

The basin proper is characterized by steep escarpments along the northern and western margins. These areas exhibit deeply incised arroyos and exposed paleosols. Emanating east from the basin rim are alluvial fans that coalesce into open undulating landforms before reaching a line of terraces and isolated knolls. Along the western margin of the basin is a series of segmented terraces that form a barrier between the water's edge and the outer escarpment. It is along these ridges that most cultural deposits occur, including LA 5148. In contrast, the southern margins of the basin exhibit deeply buried mesquite-stabilized dunes that gradually rise from the playa edge. The eastern portion of the basin also grades upward with bedrock outcrops, exposed spring vents that are in contrast to deep Holocene-aged dunes and sand sheet dune development that is also present in this portion of the playa. Coppice-dune fields, sand-sheet formations, deflation basins, and small isolated playas further characterize the environmental setting (Figure 1.3).

The floral community consists mostly of mesquite (*Prosopis* sp), shinnery-oak (*Quercus havardii*), fourwing saltbush (*Atriplex canescens*), yucca (*Yucca* sp.), creosotebush (*Larrea tridenta*), prickly pear cactus (*Opuntia* spp), sunflowers (Helianthus sp), dropseed *(Sporobolus cryptandrus*), and broom snakeweed (*Gutierrezia sarothrae*).

Most of the intact archaeological deposits identified at LA 5148, and in the surrounding area, are associated with aeolian sand deposits that are Holocene in age (Hogan 2006:2-20). Preservation is differentially distributed across the site with cultural deposits exhibiting contextual integrity along the ridge tops and in areas with well-formed anthrosols. Many deposits associated with archaeological remains have been severely deflated in areas characterized by highly deflated paleosols, resulting in the displacement of artifacts and the loss of contextual integrity (Hall 2002a, 2002b).

Figure 1.3 Photograph showing environmental setting within the project area, looking southwest

1.4 Research Goals

Traditional interpretations of southeastern New Mexico identify a generalized and ambiguous model of adaptation that interprets cultural transformation as a linear progression from mobile hunter-gatherer groups to sedentary, ceramic-using agriculturalists (Whalen 1994; Wiseman 2003). While this interpretation has proven accurate in many parts of the Southwest, the adaptive strategies practiced within the Jornada Mogollon region are more complex (Abbott et al. 1996; Condon et al. 2008b; Hogan 2006; Wiseman 2003). Current research infers that due in part to the diverse resource base associated with a semiarid environment, and possible influences from plains populations, hunter-gatherer adaptations persist well into the Formative period (Whalen 1994:632). LA 5148 may yield data that can address questions regarding settlement, subsistence, and regional interaction for the region.

This project follows a strategy employed by earlier research, which emphasizes the collection of sufficient data (spatial, technological, and geomorphological), to address questions on site structure, with special attention to chronology and function. Each data set is oriented toward addressing the larger question of adaptive behavior patterns (Condon et al. 2008b; Hard 1983; O'Laughlin and Martin 1989, 1990; Quigg et al. 2002). Within each broad research domain, specific research questions are addressed. Some of these questions have relevance to more than one research domain. As such, cultural systems represent integrated systems of behavior, and therefore, archaeological data sets are often pertinent to more than one research category.

1.5 Report Content

This document provides a detailed description of the data generated through fieldwork and analysis, and concludes with cultural interpretations and recommendations for the testing and documentation at LA 5148. The first chapter provides an introduction of the project and a brief description of LA 5148 and its setting. Chapter 2 is a summary of the paleoenvironment and present environment of the Boot Hill site environs. Chapter 3 describes the relevant culture history of the project area. Chapter 4 outlines the theoretical models under which the testing was conducted. Chapter 5 provides the framework for the research orientation and the data needs in addressing specific research questions. Chapter 6 discusses the background history of the Laguna Plata site. Chapter 7 outlines the field testing methods employed. These seven chapters establish the basic management, research, and administrative context of the project.

The second section of the report consists of site-specific results. Chapter 8 presents results of the geophysical survey and Chapter 9 describes the archaeological testing results. Chapter 10 presents the analytical methods used for the different artifact assemblages and Chapter 11 presents the site geomorphology. Chapter 12 is the lithic analysis and Chapter 13 is the ceramic analysis. Chapter 14 is the archaeofaunal analysis and Chapter 15 describes the shell artifacts. Chapter 16 presents the results of radiocarbon dating. Chapter 17 describes the 25-acre pedestrian survey and its findings. Chapter 18 is a synthesis of the various analytical conclusions and Chapter 19 addresses the research questions outlined in Chapter 5. Chapter 20 is recommendations and management concerns for the preservation and future work at the Laguna Plata site.

The report has 11 appendices (A–K) that consist of specific data analyses done by specialists (i.e., macrobotanical, pollen, diatom, stable isotope, starch grain, FTIR residue, XRF obsidian, INAA ceramic, small sherds) and results from specialized laboratories (i.e., radiocarbon assays). In addition, we have included the LCAS site report by Runyan (1971) and a summary of collections from earlier excavations at the Laguna Plata site (Graham 2010).

2.0 Environmental Background

Peter C. Condon

2.1 Introduction

This chapter discusses the geological history, ecological resources, climate, hydrology, and paleoenvironmental background associated with the Laguna Plata region. In addition, this chapter lays the foundation for developing an understanding of how prehistoric peoples interacted with their natural surroundings and how the environmental processes affected the preservation of the archaeological record within the project area.

2.2 Physiography

[redacted] Laguna Tonto, Laguna Gatuna, Laguna Tolston, and the largest playa, Laguna Plata, comprise a series of once interconnected depressions that characterize this unique environmental landscape (Laumbach et al. 1979). [redacted]

The large internally draining depression that dominates the topography was formed through the solution of the underlying bedrock and covers an area of 517.2 ha (1278 ac). The resulting basin exhibits gently sloping depositional surfaces to the south and steep deflated surfaces to the west and north. The western and northern portions of the basin contain an eroded surface demarcated by red-colored paleosols (Triassic Redbeds) and exposed sandstone outcrops. The western shoreline is further demarcated by linear curving terraces that, while unclear as to their origin, may have formed through the accumulation of alluvial sedimentation. Sandstone outcropping is also noted at the southern end of LA 5148. Alluvial gravels and small knolls are identified for the northern portions of the site. These terraces are incised by west/east running arroyos emanating from the upper rim of the basin and emptying into the playa proper.

In contrast, the southern and eastern shorelines of the basin contain aggregated aeolian sands, stabilized by vegetation. Regional dune development is the result of aeolian translocation from the Pecos River Terrace system and from slope wash accumulation initiating from the Mescalero Escarpment. This undulating topography includes sediment deposits that are Pleistocene and Holocene in age (Qe Unit, Holocene), recent alluvium (Qa Unit, Holocene), and older alluvium deposits (Qoa Unit, Pleistocene) (Hogan 2006:2-6). Within the dune settings are smaller, clay lined dunettes that retain rainwater and possible discharge when springs are active. Spring vents occur along the southeastern margins and immediately northeast of the basin's northern boundary (Haskell 1977; Laumbach et al. 1979).

Occurring within the Laguna Plata Archaeological District, LA 5148 occurs along a series of terrace remnants positioned along the western margin of the Laguna Plata basin. These remnants form an elevated barrier between the playa proper and the outer ring of the basin. This barrier is intermittently bisected by east trending arroyos emanating from the rim margin, segmenting portions of the terrace into irregularly shaped benches or knolls. LA 5148 encompasses 9.7128 ha (24 ac), and is 665.8 m (2184 ft) long and 237.6 m (779.5 ft) wide. It ranges in elevation between 1046 m (3432 ft) and 1052 m (3452 ft).

[redacted]

2.3 Paleoenvironmental Context

Paleoenvironmental reconstructions for southeastern New Mexico have traditionally relied upon inter-disciplinary data derived from Quaternary palynology, geomorphology, macro-and micropaleontology, thermoluminesence analysis, dendrochronology, and radiocarbon dating (Abbot et al. 1996) (Figure 2.2). Reconstructions based on a combination of pollen evidence and radiocarbon dates present the framework for the most widely referenced sequence of paleoclimates in southeastern New Mexico (Oldfield and Schoenwetter 1975:175). Paleoenvironmental research in the greater Southwest has tentatively correlated with stratigraphic sequences within the project area (Hall 2002). Presented in the following sections is a general overview of the paleoenvironment of southeastern New Mexico followed by a summary of Hall's (2002a, 2002b) paleoenvironmental and stratigraphic correlations for the Mescalero Plain region of New Mexico.

Environmental research indicates that during the late Pleistocene, approximately 14,000 years ago, southeastern New Mexico was characterized by warm steppe conditions with mixed grassland and boreal forest. Following, approximately 10,000 years ago, dry steppe conditions prevailed with grasses, chenopods, composites, sagebrush, oak, and juniper dominating the landscape. This increasingly semiarid continental climate with warmer summers and cooler winters continues today (Landis and Bamat 1986:22). Antev's (1948) work in the Southwest, including southeastern New Mexico, recognized the last

10,150 years of the Neothermal as comprising three distinct climatic periods: the Anathermal, the Altithermal and the Medithermal.

The Anathermal represents the period of 10,150 to 7,500 years ago. This time frame marks the transition from the cooler, moister conditions of the late Pleistocene postglacial environment to one of increasing aridity. The Altithermal extends approximately from 7,500 to 4,500 years ago and is characterized by an extremely arid environment. While Antev's (1948) model indicates a consistent lack of moisture throughout the Southwest, recent studies have suggested that these dry, drought-like conditions may not have been so widespread (Macias et al. 2000:2-10). The Medithermal represents the period from 4,500 years ago to the present. The Southwest is currently characterized by variable climatic conditions of seasonal aridity and precipitation.

From 9,000 to 8,000 years ago in southeastern New Mexico, Van Devender et al.'s results compiled from human coprolite analysis and from packrat middens has indicated a vegetation shift from woodland to grassland environments (Van Devender et al. 1987:332). Moreover, Van Devender and Spaulding (1979:709) have suggested that extreme aridity as proposed by Antev's Altithermal period may not have been indicative of the northern Chihuahuan Desert region. Monsoonal summers provided increased rates of moisture in this region as compared to regions of the northern Southwest. A final shift from grassland to desert scrub within the southeastern portion of New Mexico occurred approximately 4,000 years ago.

Variations in environmental conditions have directly affected both faunal and floral resources, and in turn, affected the resource base supporting human occupation. Juniper and oak woodlands and grass prairies supported large megafauna during the late Quaternary period. The shift from a grassland to desert scrub environment during the Holocene period forced many species into higher elevations. Smaller, more adaptable species remained in the lower elevations that characterize southern New Mexico. Subsistence patterns practiced by human populations were undoubtedly affected by this transition. While the correlation between culture and the environment is not dependent on any one factor, data preserved in the archaeological record may provide an avenue to address specific issues of prehistoric land use in the southeastern region of New Mexico (Macias et al. 2000:2).

2.3.1 Correlating Paleoenvironmental Evidence with Stratigraphic Evidence (Hall 2002a, 2002b)

The following information is taken directly from Hall’s (2002a, 2002b) geomorphic history of the Mescalero Sands and associated ancestral landscapes during the late Pleistocene period. Figure 2.1 provides a comparative paleoenvironmental table for comparison to Hall’s (2002a, 2002b) interpretative model.

2.3.1.1 100,000–130,000 (to <400,000?) B.P.

During the Sangamon Interglaciation, the regional climate was arid, perhaps drier than the Holocene. During this period of dry climate, the calcic Mescalero paleosol may have developed on the weathered surface of Permian and Triassic shale and sandstones. The Mescalero paleosol may also have formed during pre-Sangamonian periods of arid climate. The Mescalero paleosol underlies the Mescalero sands and occurs throughout the region beyond the sand sheet.

2.3.1.2 90,000–100,000 B.P.

Subsequent to the formation of the Mescalero paleosol and prior to its burial by the Unit 1 sand of the Mescalero sand sheet, an episode of erosion removed the upper soil horizons, which left behind the resistant petrocalcic horizon or caliche.

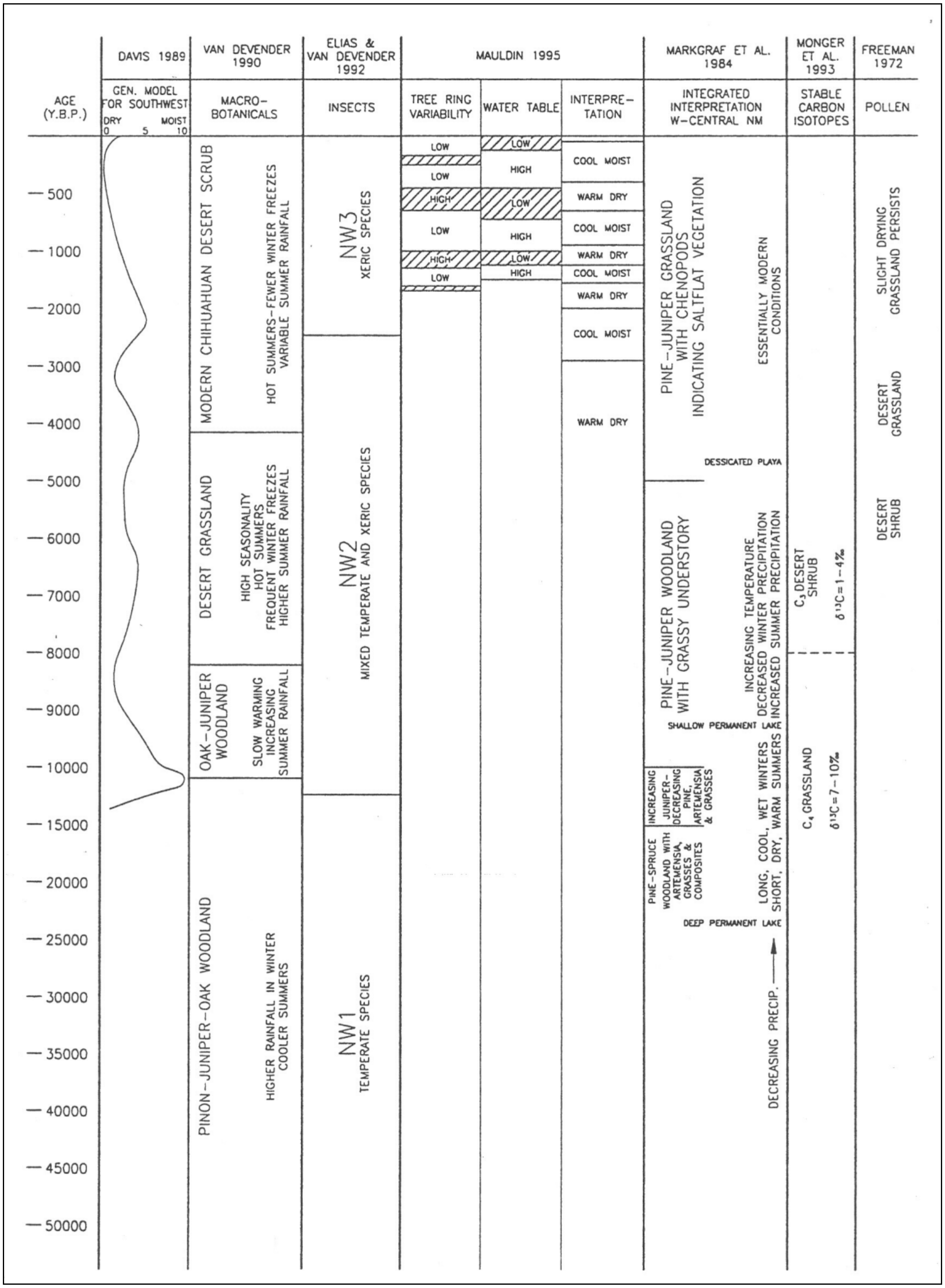

Figure 2.2 Schematic summary of paleoenvironmental data from the northern Chihuahuan Desert (Abbott et al. 1996:42; Figure 11)

2.3.1.3 70,000–90,000 B.P.

During the warm late Wisconsin (oxygen isotope stage 5A) and the early part of the early Wisconsin (stage 4), the Unit 1 aeolian sands was deposited on top of the eroded Mescalero paleosol. The source of the aeolian sand is probably alluvium derived from an eastward retreat of the Caprock escarpment of the Ogallala Formation. Unit 1 is the first aeolian sand body of the Mescalero Sands; prior to this time, the sand sheet did not exist.

2.3.1.4 15,000–70,000 B.P.

After deposition of Unit 1 sand, the sand sheet was stable during the remainder of the Wisconsinan, and a noncalcic red argillic soil formed on the aeolian sand. The Bt soil developed during the moist climate of the Wisconsin period. Because of the absence of a calcic horizon in the paleosol, the annual precipitation may have exceeded 20 inches, 50 percent more than modern rainfall. The vegetation may have been a sagebrush grassland (Hall 2002a, 2002b).

2.3.1.5 15,000–25,000+ B.P.

During the late Pleistocene, environmental conditions were cooler and wetter than today. More surface water was present west of the Caprock escarpment, as indicated by the presence of mollusk-bearing springs and cienega deposits. A higher water table in the Ogallala filled countless playa lakes on the adjacent high plains and fed numerous springs at the foot of the Caprock escarpment.

2.3.1.6 9000–15,000 B.P.

The dramatic shift to warmer and drier conditions at the end of the last glacial maximum resulted in major geomorphic, hydrologic, and biotic changes. The water table dropped, playa lakes became desiccated, springs stopped flowing, and sagebrush vanished from the grasslands. General erosion of the landscape resulted in the removal of the upper part of the Wisconsinan argillic soil, exposing the red Bt horizon at the denuded surface. During this time interval, Paleoindians may have camped at remnant springs and cienegas.

2.3.1.7 5000–9000 B.P.

During the early half of the Holocene after the shift from moist to drier climate, winds picked up fine sand from dried cienegas and streams and deposited the sand as aeolian Unit 2. The aeolian sand unit formed a mantle over the Wisconsinan red Bt paleosol and the older Unit 1 sand. The vegetation may have been desert shrub grassland. Early Archaic people may have either avoided the Mescalero Plain during the accumulation of Unit 2 aeolian sand or their sites were obliterated by aeolian processes; very few sites from this time interval have been discovered.

2.3.1.8 500–5000 B.P.

After the deposition of Unit 2 aeolian sand, the Mescalero Sands were quasi-stable; the surface vegetated but with low relief, parabolic dunes and some sand movement, perhaps resembling modern conditions. A soil did not form during this time interval, except for organic-rich anthrosols associated with prehistoric occupations. Most of the archaeological sites on the sand sheet correlate with this period of quasi-stability. The vegetation on the sand sheet was a desert grassland or desert scrub grassland, perhaps with shin oak.

2.3.1.9 100–500 B.P.

During this recent time interval, the Loco Hills soil formed on the sand sheet and on flood plains of small streams that drain through the area and on colluvial slopes. The Loco Hills is an A horizon soil that formed on stable surfaces by the accumulation of organic matter from desert grassland vegetation. The Loco Hills soil may merge with organic-rich anthrosols at archaeological sites.

2.3.1.10 0–100 B.P.

The greatest, most rapid geologic change that has occurred in the Mescalero Sands since its formation is the recent deflation of the sand sheet and accumulation of coppice and parabolic dunes. The recent erosion of the previously stable sand sheet and Loco Hills soil is probably related to historic land-use changes, especially the introduction of large numbers of grazing animals that would have affected plant cover on the sand sheet. In the past century, vast areas of the sand sheet have been deflated and the resulting sand accumulated as coppice dunes around Torrey mesquite and parabolic dunes where shinnery oak is present.

2.3.2 Commentary on Late Prehistoric Climatic History (Hall 2002a, 2002b)

The regional paleoenvironmental history of southeastern New Mexico, including LA 5148, is incomplete, although a general picture can be summarized. The hot and dry climate of the mid-Holocene, Antev's (1948) Altithermal, dominated the regional landscape. The last phase of accumulation of Unit 2 aeolian sand coincides with this period of aridity. After the Altithermal, the climate gradually became less arid. A period of slightly cooler, moister climate was evident by about 2,500 years ago and lasted to about 1,000 years ago. While slightly moister conditions during this time interval are recorded in alluvial sequences (Hall 2002a, 2002b), the Mescalero sand sheet did not respond to the moister climate, unless the response was increased vegetative cover and greater stability of the sand sheet. Similarly, the end of the interval of moist climate and change to drier conditions about 1,000 years ago had no discernible effect on the sand sheet. The peak of the recent dry conditions about 500 years ago does not seem to be visible in the sand sheet record either, although it is at this time that humic soils began to form on the sand sheet and elsewhere. While sand sheet stability and the formation of humic soils coincide with the last half of the Little Ice Age and its cooling effects at high latitudes and high elevation sites, the geomorphic response at low elevations is unremarkable despite an extended period of environmental stability.

2.4 Geology and Soil Stratigraphy

Hogan (2006:2-1), citing Katz and Katz (2001:1), states that adaptive strategies employed in the Jornada Mogollon region may be closely tied to the physiographic layout identified for the region. With this in mind, LA 5148 falls within the greater Mescalero Plain physiographic zone, a large expanse that extends west from the Southern High Plains to the Pecos River valley and south to the New Mexico/Texas state boundary (Hogan 2006:2-3). As defined by Hall (cf. Hogan 2006:2-6), the Mescalero Plain is characterized as a broad area of low relief with open expanses of parabolic and coppice sand dunes stabilized by shinnery oak and mesquite. Geologically, this area is defined by sands of Pleistocene and Holocene age (Qe), isolated outcrops of recent alluvium (Qa, Holocene), older alluvium (Qa, Pleistocene), and red bed paleosols of the Chinle (TRcu, Triassic) and Permian (Pat, Permian) groups. Using Hall's (cf. Hogan 2006:2-8, Figure 2.2) geoarchaeological zone designations, LA 5148 is associated with Unit IIB. This unit designation encompasses Pleistocene terraces, Pleistocene deposits with calcic soils, as well as younger deposits of Holocene age. These classifications provide a foundation from which a more comprehensive interpretation on site context and site formation process can be developed. However, the geological setting in which LA 5148 occurs is beyond the scope of Hall's study area for the Permian Basin Mitigation Project Research Design, and consequently, is not well documented or understood. Green's (1961) assessment of the Monahans Dune area and Nials's (1977) assessment of LA 5148 provide more relevant data for understanding the complexity of the site and its surrounding environment.

Laumbach et al. (1979:16) identified about 20 soil types and/or associations in the Laguna Plate region, however, for this study, 15 are directly applicable (Figure 2.3). Of the 15 soil types derived from the U.S. Department of Agriculture Soil Conservation Service soil survey map of Lea County, two commonly occur throughout the interior of the Laguna Plata basin (New Mexico State University; Agricultural Experiment Station 1974). The Badland soil association consists of barren areas of soft water or wind laid sediments, little vegetation, with gullied and incised surfaces. This soil association describes the areas immediate to the west and north of the Laguna Plata inner margin where well-formed arroyos bisect the landform and expose paleosols along the basin margin. The Largo-Pajarito complex identified along the southeastern margin of the playa reflects soils formed on alluvial fans. This soil series is defined by reddish-brown calcareous to non-calcareous loam and silt loam soils and soils that are formed from sandy sediments derived from aeolian and alluvial settings. The eastern and southeastern margins of the basin are defined by these well-drained soils that develop along gently sloping surfaces of playa lake benches.

2.4.1 Green (1961) and Nials (1977)

The stratigraphic sequence associated with the Laguna Plata site has been influenced by alternating periods of deflation and sediment accumulation. These cyclical episodes, interspersed with periods of stability, resulted in the development of complex and locally distinct dune formation sequences for the immediate region (Laumbach et al. 1979). Nials (Haskell 1977) interpreted the depositional processes within the Laguna Plata environment as consisting of a series of accumulating sand deposits both Pleistocene and Holocene in age. Nials's (Haskell 1977) interests have resulted in a more complex soil sequence for the project area.

The stratigraphic sequence for the project area consists of ten possible soil units, which overlay sandstone, siltstone, and sandy shale geological deposits that are Mesozoic in age. These soil units comprise the stratigraphic sequence completely or in part within the project area and are summarized in the following section. For a more detailed description of the related stratigraphic profiles, the reader is referred to Green (1961) and Nials (Haskell 1977).

2.4.1.1 Dockum Formation

The late Triassic units are associated with the Dockum Group sandstone formations, which consist of red and red-brown sandstones, siltstones, and sandy shales. Fluvial gravels that include pebbles and small cobbles of quartz, quartzite, schist, siltstone, and sandstone occur as cross-bedded lenses in this formation. This distinctively-reddish-brown colored formations are clearly exposed along the northern and western margins of the basin and are easily identified along the arroyo cut banks present at LA 5148 (Haskell 1977:21).

2.4.1.2 Unit 10-Judkins Formation

Unit 10 is interpreted by Green (1961:24) as a brownish-red, fine-to-coarse grained argillaceous sand that overlies Pliocene caliche. This argillaceous sand deposit is mottled in color, with red (2.5YR 4/8, moist) and light gray (5YR 7/2, moist) the primary color values identified in the matrix. The color gradations are interpreted as the result of iron and other mineral reduction in topographic lows and beneath late Pleistocene pond sediments. Nials (Haskell 1977) further describes this deposit as modified by clay development and characterized by firm, angular, blocky to prismatic pedogenic structure. Subangular to angular pebbles with small caliche cobbles were identified in the unit, which measured approximately34 cm in thickness (Haskell 1977:25). In the Monahan Dune environment southeast of Laguna Plata, fragments of Pleistocene mammals have been identified in the upper portions of the Judkins formation, which may reflect environmental stability and increased rainfall for the region (Green 1961:25).

2.4.1.3 Unit 9-Lacustrine Sands

Nials' (Haskell 1977:33) describes this unit as lacustrine in origin, consisting of firm to compact calcareous sands with a subangular blocky structure. This compact sand deposit is about 24 cm thick, overlies the underlying argillaceous sands of Unit 10, and is light gray (2.5YR 7/2, moist) in color. Green (1961:26) suggests that deposits equivalent with the Unit 9 sediments identified in the Laguna Plata region were formed in depressions caused by wind erosion, many of which were scoured down to the underlying caliche bedrock. The sand deposits described by Green (1961:28), and correlated by Nials (Haskell 1977:34), indicate the calcareous sands contained diatoms and ostracod shells, suggesting environmental stability and abundant moisture for the region. Unit 9 correlates with Green's (1961:28) Unit III of the Monahans Dune region of west Texas (Haskell 1977:33).

2.4.1.4 Unit 8-Aeolian Sands

This stratum, which overlies Unit 9, consists of a very pale brown (10YR 7/3, moist) medium sand deposit. This unit is 11cm thick, overlies Unit 9, and is friable in texture. In addition, Unit 8 exhibits a single grain structure, non-plastic, with little or no clay, and little or no calcium carbonate. Nials (Haskell 1977:25) indicates the contact between Units 8 and 9 is defined by a gradual to sharp, irregular boundary, suggesting at least some erosion between the two units. Green (1961:29) Unit IV deposit appear to the equivalent of Nials Unit 8, suggesting an increase in regional aridity during the early Holocene. Unit 8 sand deposits are tentatively identified in the northern margins of Laguna Plata (Haskell 1977:33).

2.4.1.5 Unit 7-Aeolian Sands

Unit 7 is described as a calcareous sand by Nials (Haskell 1977:34) and by Green (1961:30) as a calcareous gypsiferous tufa (Green's Unit V). In the Laguna Plate depression, this sand matrix consists of medium grained sands, subangular blocky pedogenic structure, with little clay or gypsum noted. Unit is 7 is described as light gray to white (2.5 7/5, moist) in color and 14 cm thick. Calcium carbonate concentrations are visible in rootlets and vertical fractures. The contact between Units 8 and 7 is gradual, suggesting an absence of erosional or deflational impacts.

2.4.1.6 Unit 6 Aeolian Sands and Alluvium

This sand deposit consists of fine to medium-grained sands within a subangular, blocky non-calcareous matrix, with little clay. Unit 6 is 6 cm thick and is reddish yellow (7.5YR 6/6, moist) in color. The contact between Unit 6 and the underlying Unit 7 is clearly defined, suggesting a period of deflation or erosion along the surface or Unit 7 prior to the deposition of Unit 6 (Haskell 1977:24). It is suggested that Unit 6, which has no parallel in Green's (1961) publication on the Monahans Dunes, is limited in extent to the inner margins of the Laguna Plata basin, and more specifically, is the orange/clay deposit described by the LCAS in 1971 (Runyan 1971).

2.4.1.7 Unit 5-Aeolian Sands

Unit 5 is a reddish yellow (7/5YR 7/6, dry) fine to medium deposit of aeolian sands. Thin lenses of coarse sands further characterize this stratum, which is weakly subangular and blocky, exhibiting a weak to moderate calcareous reaction to hydrochloric acid. Minimal clay sediments are associated with this stratum. Unit 5 is further delineated by aeolian cross bedding with thin lenses of darker-colored laminae (Green 1961:31). The contact between Units 6 and 5 is sharp and easily defined, suggesting an erosional episode defining the boundary between these two units. Nials (Haskell 1977:35) Unit 5 correlates with Green's (1961:31) Unit VIII.

2.4.1.8 Unit 4-Aeolian Sands

Unit 4 is a very pale brown (10YR 7/5, dry), fine to medium deposit of aeolian loamy sands. Thin lenses of coarse sands further characterize this stratum, which is weakly subangular and blocky, and has a weak to moderate calcareous reaction to hydrochloric acid, with little or no clay sediments. Sediments are slightly compacted, with cross-bedded argillaceous laminae (5YR 4/6, yellowish red), suggesting periodic rainfall, and the stabilization of dune formation (Green 1961:32; Haskell 1977:24).

2.4.1.9 Unit 3-Aeolian Sands

Unit 3 is a very pale brown (10YR 7/5, dry), fine to medium deposit of aeolian sands associated with dune development. This stratum is weakly subangular and blocky, weakly calcareous, with little or no clay sediments (Haskell 1977:24). Unit 3 sands are associated with stabilized dunes and are about 28 cm thick in the Laguna Plata area (Haskell 1977:24).

2.4.1.10 Unit 2-Aeolian Sands

Unit 2 is a brown (10YR 5/4, dry), fine to medium deposit of aeolian sands associated with dune development. This stratum is weakly subangular and blocky, weakly calcareous, with little or no clay sediments (Haskell 1977:24). The internal homogeneity of this deposit is interrupted by several thin deposits of humic deposition, suggesting periods of sedimentation during periods of environmental stability and increased precipitation (Haskell 1977:35).Unit 2 sands are associated with stabilized dunes and ranged from 18–22 cm thick.

2.4.1.11 Unit 1-Modern Sand Development

Unit 1 is a very pale brown (10YR 7/4, dry), fine to medium deposit of aeolian sands associated with dune development. This stratum is weakly subangular and blocky, weakly calcareous, with little or no clay sediments (Haskell 1977:24). Unit 1 sands are associated with modern stabilized dunes development and ranged from 8–10 cm thick.

2.5 Water Resources

Laguna Plata is generally considered hydrologically isolated, primarily receiving water from local precipitation and through springs along the southeast and northeast margins of the basin (Figure 2.4). Annual precipitation, which averages 33.02 cm (13 inches), also pools in the basin, creating a potable water source for animals, as documented by Haskell (1977 et al.) and viewed by the TRC crew. Hall (2002) and Bamforth (1988) suggest the numerous small basins and intermittent arroyos within the Mescalero Plain may have provided a semi-permanent water source on a seasonal basis for small groups of hunter-gatherers living in the region. The underlying brine water commonly associated with Laguna Plata may not have been adequate for human consumption, but potable enough to support plant and animal communities. Moreover, the salt content may have yielded economic value for both prehistoric and historic populations.

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Laguna Plata and other smaller, localized playas are intermittently recharged from the infiltration of water from spring activity along the southeast and northeast margins of the basin. Small springs or seeps form directly out of the porous alluvium or exposed Permian-aged bedrock deposits and are noted in the southeast boundary of the playa at the 3,400 ft contour. Although these springs currently contain natural brines, their salinity would have been much lower prehistorically. The spring outflow is initially captured in low-lying clay-lined deflations easily recognized in Figure 2.4. A larger northeast/southwest trending channel empties into the Laguna Plata proper, providing a water source for the basin. The northeast margin of the basin also contains at least one spring vent that also provides a source of water for the playa. The effect of seasonal moisture in the playa environment is expressed by increased vegetation within localized niches and the increased presence of wildlife. Areas adjacent to the prehistoric springs may have contained potential campsite loci, such as exemplified by the prehistoric occupation of the terraces west of the springs (Ashley 2001:183; Laumbach et al. 1979:17). Cattail (*Typha* sp.) pollen recovered from LA 5148 by ENMU-ACA in 1977 infers lower salinity in the playa than is currently present (Haskell 1977:325; Laumbach et at. 1979:17). Historic lowering of the water table has subsequently dried up many of the springs that were once used prehistorically. While large springs have been identified in Lea County, these point-depositional water sources are not an accurate reflection of past water sources.

2.6 Climate

This region of southeastern New Mexico is characterized by a steppe climate as defined by the Koppen-Geiger system of classification (Haskell 1977:40). In a regional context, southeastern New Mexico reflects a low annual humidity, low annual precipitation, and a high average annual temperature (Reeves 1972:108). The project area lies well within the Chihuahuan biotic province, which is defined by a climate that is typical of other arid regions of the American Southwest and Northern Mexico (Dice 1943). Precipitation occurs primarily in the form of brief, occasional thunderstorms that characterize the summer months. Humidity ranges from 20–60 percent in the Carlsbad and Hobbs areas of New Mexico (Haskell 1977:41). From 1914 to 1974, the Carlsbad region had an average temperature of 62.6^{o}F with an annual mean precipitation of 12.45 inches of rainfall. Hobbs had a mean annual temperature of 61.70^{o}F with an annual mean precipitation of 15.935 inches (Haskell 1977:42).

2.7 Biological Resources

A wide array of plant and animal resources has been identified within the Chihuahuan Desert. However, the identification of available resources during the prehistoric period is difficult, due in part to the shifting of environmental communities through time (Dick-Peddie 1993:131). Nonetheless, a review of the plant and animal species that inhabit the desert environment, and particularly the Laguna Plata project area, may provide a proxy measure of the range of resources available to the prehistoric populations of the region.

2.7.1 Flora

According to Shelford (1963:374), the Chihuahuan Desert has two main districts based on plant distributions: 1) the northern *Larrea-Yucca*, and 2) the southern succulent desert. The northern Chihuahuan Desert has plants with few leaves and straight stems that are adapted to slightly more arid conditions than other North American desert areas. Creosote bush (*Larrea tridentata*) and soaptree yucca (*Yucca elata*) dominate in well-drained, calcareous soils. Honey mesquite (*Prosopis glandulosa*) is common in sandy soils along arroyos or playa margins.

Modern vegetation is partially conditioned by landscape position, elevation, and sediment types (Kenmotsu 1977; Satterwhite and Ehlen 1980). Plants in the Laguna Plata region are typical of the Chihuahuan Desert and include grasses, forbs, and shrubs adapted to xeric conditions. At higher elevations, plants reflect the presence of greater moisture availability and are mostly grasses and shrubs.

During much of the Holocene, grasslands were widespread at low-lying elevations, but historic disturbances and cattle overgrazing have allowed xeric species to invade and dominate these areas.

The project area lies within the Mescalero Plain, covered by Chihuahuan Desert scrub. Archaeological sites located on the pediment most commonly contain black grama (*Bouteloua eriopoda*), chino grama (*B. chrondrosioides*), bush muhly (*Muhlenbergia porteri*), broom snakeweed (*Gutierrezia sarothrae*), drop seed grass (*Sporobolus* spp.), sotol (*Dasylirion* sp.), agave (*Agave* spp.), honey mesquite (*Prosopis glandulosa*), creosote bush (*Larrea tridentata*), soaptree yucca (*Yucca elata*), prickly pear cactus (*Opuntia* spp.), Mormon tea (*Ephedra*), catclaw acacia (*Acacia greggii*), desert hackberry (*Celtis pallida*), and fourwing saltbush (*Atriplex canescens*).

2.7.2 Fauna

The contemporary environment provides an adequate habitat for a variety of mammal, bird, and reptile species. Macroscopic invertebrates are also common and diverse, including insects such as flies, ants, beetles, termites, millipedes and centipedes, arachnids, and occasional worms and snails, especially at higher altitudes. Ants and termites are common throughout the northern Chihuahuan Desert and are identified as a causal factor in the bioturbation that is pervasive on the Mescalero Plain. Some of the more common fauna in the project area include coyote (*Canis latrans*), pronghorn (*Antilocapra americana*), desert cottontail (*Sylvilagus audubonii*), jackrabbit (*Lepus californicus*), Kangaroo rat (*Dipodomys* spp.), mourning dove (*Zenaida macroura),* red-tailed hawk (*Buteo jamaicensis),* various species of lizards, and several species of snakes (Abbott et al. 1996; Castetter et al. 1938).

2.7.3 Ecology

Until the modern development of intensive agricultural and ranching practices within southeastern New Mexico, human subsistence was dependent on naturally occurring floral and faunal resources. Resource abundance is a function of environmental parameters that are bounded by climate and soil factors. Consequently, an understanding of the vegetative ecology is required in considering changes in prehistoric land-use patterns.

The classification of southeastern New Mexico into vegetation zones is broadly based on elevation, soil development, and hydrology. Consequently, lowland areas, including microhabitats such as the Laguna Plata basin, will differ from upland environments, such as the grasslands of the Llano Estacado. The classification system considers dominant vegetation species only. Dominance is the ability of one species to influence the environment of another and is commonly expressed by biomass and ground cover characteristics.

Variation in vegetation zones is shown in Figure 2.5, which shows floral-cover type within the nine counties that comprise southeastern New Mexico. The Mescalero Plain falls within the Plains-Mesa Sand Scrub classification that is dominated by mesquite (*Prosopis glandulosa*), creosote bush (*Larrea tridentata*), fourwing saltbush (*Atriplex canescens*), and in select areas, shinnery oak (*Quercus havardii*). Although most of the project area is composed of scrubland, the overall vegetation patterns provide a proxy measure for interpreting prehistoric adaptation within specific ecological zones.

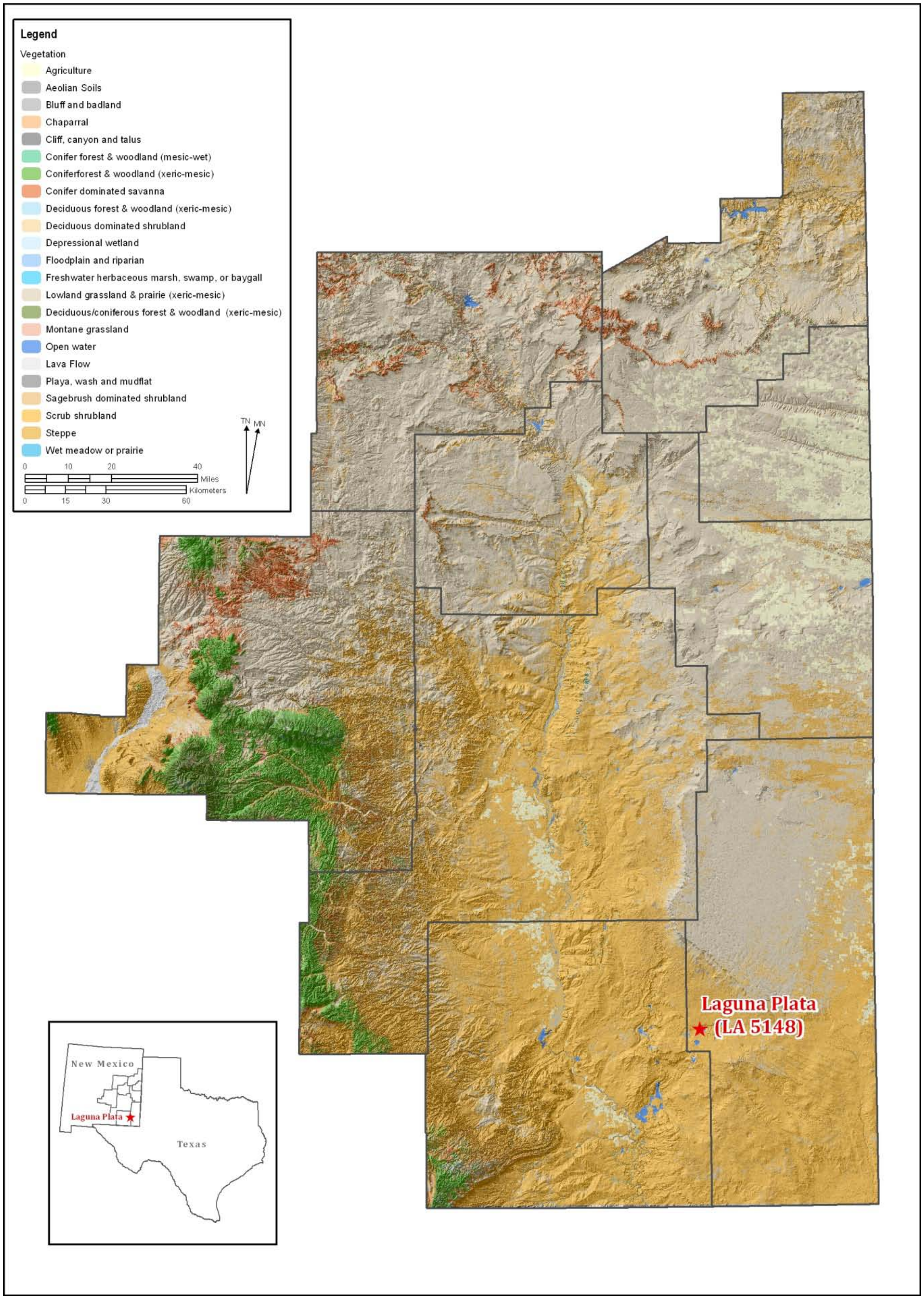

Figure 2.5 Vegetation zones of southeastern New Mexico

3.0 Cultural History

Peter C. Condon

3.1 Introduction

This abbreviated culture history is intended to familiarize the reader with a broad and generalized regional contextual setting for the Laguna Plata site. Following Hogan's (2006) suggestion, this cultural overview borrows heavily from Katz and Katz (1985), and attempts to correlate with other historic overviews.

In addition to providing a cultural overview from which to interpret the Laguna Plata occupational events within a cultural/temporal framework, this chapter attempts to integrate a cultural/temporal typology with site typology by using morphological attributes (Hogan 2006:3-2). This approach will accomplish two objectives, each with the goal of answering research questions and evaluating sites for future preservation efforts. The first objective focuses on identifying how archaeological sites are spatially distributed through time, and the second is to discern and compare occupational components through time within a common physiographic region (Hogan 2006).

By using this integrated approach to site interpretation, a more refined understanding of site occupation, land use strategies through space and time, and how physiographic elements play a role in prehistoric behavior, can be demonstrated. The first section of this chapter provides a generalized cultural overview followed by an evaluation of the Laguna Plata site occupation through time.

3.2 The Paleoindian Period (10,000–5200 B.C.)

The Paleoindian period (10,000–5500 B.C.) includes the earliest recognized cultures in the American Southwest and is divided into three sub-periods or complexes. At the closing of the Pleistocene epoch, most of New Mexico was covered by montane coniferous forest composed of fir and pine trees (Dick-Peddie 1993:16). At approximately 11,000 to 10,000 B.C., Douglas fir, white pine, and dwarf juniper were present at an elevation of 2,000 m in the Guadalupe Mountains (Dick-Peddie 1993:16). Now-extinct megafauna, such as mammoth (*Mammuthus primigenius*) and a more robust form of bison (*Bison antiquus*), roamed the lush grasslands and congregated to drink at playa lakes. Paleoindians hunted these late Pleistocene mammals and most likely scavenged the dead or diseased when the opportunity presented itself. These highly mobile people are primarily known through their distinctive tool kit, which is characterized by several lithic technologies, highlighted by fluted and parallel-flaked projectile points. The degree to which Paleoindians subsisted on vegetal resources is little understood. However, current research has indicated that the long-held belief that Paleoindian groups subsisted primarily on megafauna is being replaced with a more generalist model. It is likely both faunal and floral remains constituted a measure of equal importance within the Paleoindians dietary strategy. While Paleoindian groups represent the earliest recognized inhabitants of North America, the possibility of human occupation predating 10,000 B.C. must be considered. With new data from South America providing alternate theories and alternate dates for human occupation in the Americas, the 10,000 B.C. beginning date for the Paleoindian occupation of North America should be considered tenuous.

3.3 The Clovis Complex (Paleoindian I: 10,000–9000 B.C.)

The Clovis complex is identified by characteristic large fluted projectile points and is generally accepted to be the earliest human occupation of the Americas. Excavation of Hermit's Cave, located in Last Chance Canyon in the Guadalupe Mountains, produced late Quaternary radiocarbon dates. The charcoal samples, potentially representing the human occupation of Hermit's Cave, were also associated with mammoth and dire wolf remains (Sebastian and Larralde 1989:29). E. B. Howard's excavations at Burnet Cave, which is along the southern portion of Rocky Arroyo, produced a Clovis point in association with bison bones. A single radiocarbon assay provided a late Paleoindian date of 7432±300 B.P. (Sebastian and Larralde 1989:31). A survey of the high country of Guadalupe Mountains National Park documented a Plainview and a Meserve point representing the late Paleoindian period (Katz 1978:55). Finally, Smith et al. (1966) report early Paleoindian components identified at the Rattlesnake Draw site west of the caprock. As of June 1990, an estimated 19 sites containing Paleoindian components were recorded in a variety of topographical settings throughout Eddy County (Katz and Katz 1993).

The Clovis lithic tradition is characterized by two diverse technologies: a biface-oriented technology resulting in large fluted projectile points, and a core and blade technology, which results in large, curved prismatic blades (Collins 1999a, 1999b; Green 1963; Hester 1972; Stanford 1991). Variation in Clovis assemblages has been traditionally viewed as limited, although current research seems to indicate more variability in tool type (Collins 1999a:46). Examination of stone selection reflects a preference for high-grade chert and chalcedony. However, locally available materials, such as quartzite, silicified woods, and shales are commonly identified within Clovis-aged assemblages (Hester 1972). Interpretation of the highly mobile subsistence and settlement patterning for the Clovis period is strengthened by the predominance of nonlocal raw materials, such as obsidian, basalt, chert, and chalcedonies from west and central Texas.

3.4 Folsom Complex (Paleoindian II: 9000–8000 B.C.)

The Folsom complex immediately follows, and in some cases, overlaps in time with the preceding Clovis complex. Regional dates are derived from several sites in southeastern New Mexico, including Blackwater Locality No. 1, the Elida Site, and the Milnesands site (Agogino and Rovner 1967; Boldurian 1981; Broilo 1971; Cotter 1938; Hester 1972; Stanford and Broilo 1981; Warnica 1959). The Folsom complex is associated with a changing environment, which is characterized by the extinction of large megafauna and an increase in the *Bison antiquus* population. Unlike the Clovis complex, where reliance on megafauna has been accepted for years on an *a priori* basis, Folsom subsistence patterns show evidence for reliance on bison exploitation.

Both the Clovis and Folsom lithic traditions possess many technological similarities. These similarities have often been interpreted as a continuation of one lithic technology passed between similar groups. However, further analysis has shown that Clovis and Folsom lithic traditions possess only tentative parallels and that each tradition is individualistic and unique. In general, the Folsom lithic tradition is distinguished by a variety of reduction strategies and subsequent tool forms. Traditional evidence indicates Folsom lithic technologies were dominated by flake removals from bifacial cores. The lanceolate, fluted point that exemplifies Folsom technology is distinguished from the Clovis fluted projectile point by a generally smaller size, the length, and morphology of the flute, parallel flaking of the lateral margins, and more extensive grinding on the lower lateral margins. Significantly, Folsom projectile points are predominantly produced from flakes. Additionally, the characteristic attributes that define the Folsom are commonly absent. Unfluted lanceolate forms, identified as Midland points, coexist within Folsom-aged sites in southeastern New Mexico (Sebastian and Larralde 1989:31). Folsom assemblages often reflect more variability in tool type than earlier traditions. Raw-material selection associated with Folsom assemblages consistently retains high percentages of cryptocrystalline silicates, as well as local materials, such as quartzite and silicified sandstone (Hester 1972:120). Folsom subsistence and settlement strategies are generally more restricted than recognized for the Clovis period. Subsequently, Folsom groups are viewed as highly mobile, but generally limited to the Great Plains and its peripheries. Within southeastern New Mexico, Folsom-aged artifacts have been reported from Burnett Cave south of Carlsbad, from the Boot Hill site northwest of Maljamar, New Mexico recently at LA 165710 southwest of Laguna Plata, and from LA 22122 (NMSU 578) along the eastern margin of Laguna Plata in Lea County, New Mexico (Corley and Leslie 1971; Howard 1935; Laumbach et al. 1979; and Lukowski et al. 2010).

3.5 Late Paleoindian Complexes (Paleoindian III: 8000–5500 B.C.)

The subsequent complexes following Folsom are generally less understood than either of the earlier Paleoindian complexes. Lithic technology is characterized by non-fluted, parallel, or collaterally flaked lanceolate-shaped projectile points. However, morphological variability is evident within projectile point assemblages dating to this period. The variability in point styles has formed the basis for defining a number of different complexes including Agate Basin, Firstview, Plainview, Frederick, Hell Gap, Alberta, and Cody. Traditional interpretations for subsistence patterns have continued to support a reliance on *Bison antiquus,* but assume that a shift towards a more generalist subsistence strategy is slowly taking precedence. When the transition from late Paleoindian to Archaic-oriented subsistence and settlement organization actually occurs is ambiguous. Lack of reliable dates from buried sites hinders the current interpretation of this period. Regionally, a possible Plainview variant was recovered from the Maroon Cliffs site, located west of the Laguna Plata site (Hurst 1976:49).

3.6 The Archaic Period (5500 B.C.–A.D. 500)

The Archaic period is characterized by a diversification of subsistence strategies and an apparent intensification of resource exploitation (Stuart and Gauthier 1984). With the extinction of many species at the Pleistocene to Holocene interface, a variety of smaller resources becomes more critical to the subsistence strategies of the early Holocene populations. Lithic technology, perhaps reflective of a more generalist, nomadic subsistence pattern, also appears more stylistically varied. The appearance of ground stone tools may attest to an increasing reliance on floral resources.

As of June 1990, 162 Archaic period sites were recorded in a variety of topographical settings throughout Eddy County, New Mexico (Katz and Katz 1993). A more recent study of radiocarbon dates derived from excavations conducted in southeastern New Mexico identified 30 out of 229 samples that date to the Archaic period (Railey, Risetto, and Bandy 2009). Based on these dates, the authors identified three periods of increased occupation using summed radiocarbon probability data: 1) 2600–2300 B.C., 2) 1900–1600 B.C., and 3) 1400–300 B.C. (Railey, Risetto, and Bandy 2009:50). These data tend to highlight a near absence of radiocarbon samples that date prior to 3000 B.C., as exemplified by Katz and Katz (1985). During the Brantley Reservoir project, 17 Archaic period components were identified and radiocarbon dated. However, not one of the 17 sites predated 3000 B.C. (Katz and Katz 1985:35). Nonetheless, an early Archaic period presence is suggested by the recovery of diagnostic projectile point bases (Katz and Katz 1985:35). Roney (1985:68) reports two Archaic period dates from Hooper Canyon Cave, which is in Dark Canyon on the eastern flanks of the Guadalupe Mountains. Wood charcoal samples from a layer directly overlying the cave floor yielded radiocarbon dates of 395±90 B.C. and 940±110 B.C. (Roney 1985:68). Applegarth's (1976:165) excavation of Honest Injun Cave and Dark Canyon Cave yielded Archaic period materials including baskets, large corner-notched projectile points, basin metates, atlatls and darts. She notes that limestone was used extensively in tool manufacture, comprising more than 50 percent of the tool stone recovered from Hermit's Cave, Honest Injun Cave, and Dark Canyon Cave (Applegarth 1976:166). A range of Early to Late Archaic period projectile points were observed on sites recorded during a survey of the high country of Guadalupe Mountains National Park (Katz 1978:55). Investigation of ring-midden sites at the South Seven Rivers site and the Sheep Draw Canyon yielded nine radiocarbon dates ranging from 1245 B.C. to 900 B.C. and 1920 to 410 B.C., respectively (Condon 2002; Wiseman et al. 1999). These dates place these features firmly in the Middle and Late Archaic periods.

Katz and Katz (1993) provide a regionally oriented cultural sequence for the Archaic period for southeastern New Mexico. While their classification system establishes a mechanism for chronological control of datable sites, the temporal range for the Archaic period is often too broad and too ambiguous for precise statements of interpretation (Katz and Katz 1993:101). Despite the temporal flexibility, the cultural sequence does present a much-needed framework for the development of a more accurate series of chronological parameters for a temporal period that spans more than 5,000 years. The cultural sequence proposed by Katz and Katz (1993:104) is presented below.

3.6.1 Archaic I (5500–1700 B.C.)

This first regional phase for the Archaic period is relatively ambiguous with regard to defining characteristics. Chronological seriation for this Early Archaic phase is based tentatively on a single stylized biface, or projectile point (Irwin-Williams 1973:5; Katz and Katz 1993:119; Stuart and Gauthier 1984). This projectile point, identified as a Jay point, is a morphologically unique lanceolate form whose most discerning characteristics are its weak shoulders and a long tapering stem (Irwin-Williams 1973:5; Katz and Katz 1993:119). While data defining the Jay complex has not been associated with a dated context within the region, Katz and Katz (1993:119) noted morphologically similar projectile points have been recovered from Eddy County. The Archaic I is culturally and temporally correlated with the Avalon phase (3000 to 1000 B.C.) designated at LA 44544 during the Brantley Reservoir project.

3.6.2 Archaic II (1700–1000 B.C.)

The Archaic II represents the second cultural component within the Archaic sequence for the region and is defined primarily from data retrieved from a single site (LA 44544) along the Pecos River (Katz and Katz 1985:398; 1993:119). This phase of the Archaic period is reflective of the preceding Archaic I in that artifact types correlated with radiocarbon assays are relatively nonexistent. Chronological control was solely based on radiocarbon dates recovered from isolated fire-cracked rock features (Katz and Katz 1985:397; 1993:119). However, more recent data from Puntos de los Muertos (LA 116471) in Eddy County, provides additional chronometric information from similar burned rock features (Wiseman 2003:166). The lack of a typological assemblage for the Archaic II exemplifies the need for documented evidence for the Middle Archaic period. The Archaic II is culturally and temporally correlated with the Avalon phase (3000 to 1000 B.C.).

3.6.3 Archaic III (1000 B.C.–A.D. 1)

The Archaic III phase period is equated with the McMillan phase of the regional cultural sequence. Chronological parameters were developed from radiocarbon dates obtained from LA 38233 along the Pecos River (Wiseman 2002). Medium-sized, stemmed projectile points that possess triangular blade outlines and pronounced shoulders distinguish the lithic assemblage (Katz and Katz 1993:119; Leslie 1978:133). Additional cultural attributes include the presence of large burned-rock features. Angular-shaped burned-rock features excavated at LA 131686 located near Sheep Draw Canyon in Eddy County yielded conventional radiocarbon ages of 3130 ±50 B.P. and 3430±70 B.P., and calibrated ages of 1500 to 1260 B.C. and 1920 to 1600 B.C., respectively. In a similar fashion, LA 131687, also situated south of Sheep Draw Canyon, yielded conventional radiocarbon ages of 2460±40 B.P. and 2770±40 B.P. and calibrated age ranges of 670 to 410 B.C. and 1010 to 820 B.C., respectively (Condon 2002). These wood charcoal dates occur firmly within the Archaic III age range and augment the existing chronometric data for this period. More recent excavations at LA 154539 carried out by Lone Mountain Archaeological Services near Cedar Canyon, Eddy County, yielded radiocarbon dates and accompanying assemblages that suggest site use between 760 and 680 B.C. and 670 and 400 B.C. (Boggess et al. 2009). The Archaic III is culturally and temporally correlated with the McMillan phase (1000 B.C. to A.D. 1).

3.6.4 Archaic IV (A.D. 1–500)

The Archaic IV stage of the cultural sequence for southeastern New Mexico is defined by type-sites LA 38276 and LA 48761. Data derived from these two sites along the Pecos River provided the framework for the development of the Brantley phase of the Archaic period. The Brantley phase represents the transitional stage between the Archaic period and the Formative period within the southeastern region of New Mexico. The lithic assemblage for this Archaic phase is characterized by projectile points that tend to be triangular with weak to pronounced shoulders. The stem characteristics vary between straight and expanding hafting elements. The proximal characteristics also include straight and convex bases (Leslie 1978:122). Projectile points common to this phase are San Pedro and the recently defined Pecos point (Wiseman 2002:7). The presence of burned-rock features appears to increase in frequency within the Brantley phase (A.D. 1 to 750) of the Archaic period (Katz and Katz 1993:120).

3.7 The Formative Period (A.D. 500–1375)

The late Prehistoric period is marked by the introduction of ceramic technology and the presumed introduction of the bow and arrow. Within the southeastern New Mexico region this period is commonly referred to as the Formative period (Katz and Katz 1993:1–126; Roney 1985:47; and Sebastian and Larralde 1989:73). While evidence for the use of agriculture is extremely limited within this portion of New Mexico, domestication of plants is relatively well documented in peripheral areas. The lack of evidence for plant domestication within the southeastern region of New Mexico presents an enduring enigma that has continued to hinder attempts at interpreting subsistence patterns in southeastern New Mexico. The lack of evidence for agriculture, and associated sedentism, does not preclude its assumed application within the region. A primary reliance on a hunter-gatherer existence is traditionally assumed for this region of New Mexico.

As of June 1990, 667 Formative or late Prehistoric period sites were recorded in a variety of topographic settings in Eddy County. A slight majority of these sites (n=356) are in dunal settings (Katz and Katz 1993). To the southwest, in the high country of the Guadalupe Mountains, Katz (1978:87) tested a ring midden with associated E1 Paso Polychrome and Jornada brownware sherds, as well as Perdiz and Livermore projectile points. The feature yielded a radiocarbon date of A.D. 710±50, placing it in the early Formative period. More recent projects such as test investigations at LA 43315 near Loco Hills, New Mexico yielded brownware sherds and a radiocarbon date with a calibrated range of A.D. 887 to 1023 (Boyer 1995:30). Excavations at LA 104607, which is along Bear Grass Draw east of Artesia, produced 40 El Paso Bichrome sherds and a single charred maize kernel (Clifton 1995:25). Recently, several late Prehistoric period structures and extramural features were excavated at the Macho Dunes site in advance of construction activities associated with the Carlsbad Relief Route (Zamora 2000). Excavation at LA 68188 (i.e., the Fox Place Site) exposed 12 pit house structures, one socio-religious structure, storage pits, and numerous maize cob fragments. Twelve radiocarbon assays provide an occupational range dating between A.D. 1250 and 1450.

The cultural sequence developed by Leslie (1978) for the eastern extension of the Jornada Mogollon is commonly applied to sites in the vicinity of Carlsbad. This sequence, which is based on earlier work by Lehmer (1948) and Corley (1965), roughly follows the pithouse-to-pueblo transition found in the other major cultural areas of New Mexico and west Texas. However, these earlier cultural frameworks are based on a definitive transition from a hunter-gatherer subsistence model to an agriculturally based society. These cultural sequences are not easily applied to the southeastern region of New Mexico. Katz and Katz (1985; 1993) provide a more regionally accepted cultural sequence for the southeastern region of New Mexico, which has been modified herein. Katz and Katz (1993) present a cultural sequence for the Formative period that is subdivided into seven phases. These phases have been developed upon more regionalized fieldwork and attempt to create a synthesis based upon locally available data.

3.7.1 Formative I (A.D. 500–750)

The initial phase of the Formative Period is broadly characterized by the introduction of ceramic technology. While ceramic technology distinguishes the Formative period from the Archaic period, many of the associated subsistence and settlement patterns that are attributed to later sites are absent. In fact, one might argue that the cultural attributes associated with the early Formative period represent a continuation of the preceding Archaic period (Katz and Katz 1993:126). The material attributes associated with the Formative I phase include a smaller-sized projectile point, similar to Leslie's Types 5 and 6, and regional types identified as Scallorn points.

An increased presence of ground stone is also noted for this phase. The ceramic technology consists of plain brownwares, Jornada Brown, Middle Pecos Micaceous Brown, South Pecos Brown, and Alma Plain pottery types. Local phases associated with this period are the late Hueco (Leslie 1979), the early 18 Mile (Jelinek 1967), and the Globe phase (A.D. 750 to 1150) (Katz and Katz 1993).

3.7.2 Formative II (A.D. 750–950)

The second phase of the Formative period is distinguished by the introduction of bow-and-arrow technology and subsequently much smaller stylized bifaces. The typological classification for the stylized bifaces include Leslie's Types 3A, 3B, and Scallorn projectile point variants. Ground stone technology mimics the preceding phase with the presence of manos, metates and bedrock mortars. Ceramic types include brownwares, such as Middle Pecos Micaceous Brown and South Pecos Brown, as well as the introduction of black-on-white pottery types (Cebolleta Black-on-white). Local phases for the Formative II include the early Querecho (Leslie 1979), the late 18 Mile (Jelinek 1967), and the middle portion of the Globe phase (Katz and Katz 1993:128).

3.7.3 Formative III (A.D. 950–1075)

While many of the general characteristics of the preceding phase continue during this third phase of the Formative period, an increase in stylized biface variation is recognized. Corner-notched stylized bifaces are characteristic of this phase and include Leslie's Types 3A through 3F. Ground stone assemblages are characterized by oval basin metates and convex-faced manos (Katz and Katz 1993:129). Ceramic types continue to include local brownwares; however, the introduction of graywares into the region is identified during the Formative III phase. Local phases include the early Mesita Negra and Middle Pecos I (Jelinek 1967, A.D. 950 to 1100), the late Globe (Katz and Katz 1985), and the Querecho phase (Corley 1965, A.D. 950 to 1100).

3.7.4 Formative IV (A.D. 1075–1125)

The fourth phase is characterized by a general continuation of the preceding phases with regard to material attributes. However, Katz and Katz (1993:129) indicate that the settlement pattern is markedly different from the Formative III phase. A shift from surface architecture to subsurface rooms is identified for this middle Formative phase. The ceramic typology continues to include localized brownwares such as McKenzie Brown. An increase in graywares is noted for this phase, as is the introduction of the Chupadero Black-on-white pottery type. Local phases include the late Mesita Negra and Middle Pecos I and II (Jelinek 1967, A.D. 950 to 110 and A.D. 1100 to 1200), the pre-Crosby phase, late Globe to early Oriental (A.D. 1150 to 1450, Katz and Katz 1993:130), and the early Maljamar phases (Corley 1965, A.D. 1100 to 1300).

3.7.5 Formative V (A.D. 1125–1200)

The fifth phase is demarcated by a shift from a riverine orientation to an increased upland settlement pattern. Lithic assemblages are characterized by a corner-notched stylized biface including Leslie's Types 2A and 2B projectile points. The ceramic assemblages continue to include brownwares. However, the presence of nonlocal pottery types is commonly associated with site assemblages from this phase. Local phases include the early McKenzie, the Crosby phase, the early/middle Oriental phase, and the late Maljamar phase (Katz and Katz 1993:130).

3.7.6 Formative VI (A.D. 1200–1300).

According to Katz and Katz (1993:131), this late Formative phase is characterized by an increase in site density and the increased evidence for agriculturally based subsistence strategies. The presence of bison remains and maize pollen have been identified for this phase. The cultural assemblages continue to include corner-notched projectile points. The ceramic assemblage includes textured and corrugated brownware (Leslie 1979). Local associated phases include the late McKenzie phase, the Roswell phase, the middle Oriental phase and a transitional phase designated the Ochoa phase (A.D. 1300 to 1450) for southeastern New Mexico (Katz and Katz 1993:131).

3.7.7 Formative VII (A.D. 1300–1375)

The seventh phase for southeastern New Mexico potentially corresponds with the environmental episode identified as the Little Ice Age. In the project area, the introduction of small stone circles within site loci is complemented by variation in the cultural assemblage. Lithic assemblages often include shaft straighteners, scrapers, and the increased presence of obsidian artifacts. A small, corner-notched, basal-notched projectile point is recognized as the diagnostic projectile-point type for this phase. The ceramic assemblage exhibits an increased frequency in nonlocal pottery including painted wares, and textured brownwares (Katz and Katz 1993:132). Post-A.D. 1375 phases include the Phoenix phase (A.D. 1450 to 1540) and the Seven Rivers phase (post A.D. 1540).

3.8 Protohistoric to Historic Periods (A.D. 1375–Present)

Cabeza de Vaca, along with other survivors of a Spanish shipwreck on the Texas coast, probably passed through the southern portion of southeastern New Mexico on their return to Mexico in 1535 (Scurlock 1989:53). Later in 1541, Francisco Vasquez de Coronado first entered the area on an expedition to or returning from the Southern Plains in search of the riches of "Quivira" (Scurlock 1989:53). In the late sixteenth century, Antonio de Espejo and Castano de Sosa led expeditions that followed the Pecos River Valley through southeastern New Mexico (Williams 1986:92). Native groups encountered by the Spanish were nomadic Apaches and Jumanos. In 1630, Fray Alonso de Benavides mentioned a temporary encampment of Jumanos that was potentially on the plains east of Carlsbad (Kelley 1986:20). Based on historical evidence, Kelley hypothesizes that the Jumanos, a nomadic people, possibly occupied the Pecos River Valley in the vicinity of Carlsbad (1986:22). From 1650 into the early nineteenth century, several Spanish military expeditions entered southeastern New Mexico in hopes of engaging these nomads either commercially or militarily. Slave raiding was also part of the Spaniards' agenda (Katz and Katz 1985:51; Scurlock 1989:55). Apache groups that were encountered by the Spanish include those called Querechos, Vaqueros, and Faraones. The Siete Rios Apache, a group that inhabited an area near present-day Carlsbad, were first mentioned in 1659 (Scurlock 1989:37). In the late nineteenth century, these Apache groups and others became part of the Mescalero Apaches (Scurlock 1989:37). Comanches began entering the area by the middle of the nineteenth century (Scurlock 1989:38).

By the mid-nineteenth century, livestock ranchers were migrating into southeastern New Mexico, attracted by the offer of available grazing land. The Homestead Act of 1862 guaranteed citizens a quarter section of land if it was settled and improved. By the 1880s, the Eddy brothers and the Pecos Irrigation and Investment Company were attempting to irrigate the Pecos River Valley, supplying much-needed water to farms in the area. The railroad reached Eddy County in 1891. In 1899, the residents of Eddy, New Mexico, voted to change the name of their town to Carlsbad in order to promote the medicinal qualities of nearby springs that were likened to those in Karlsburg, Germany (Katz and Katz 1985:92).

Guano was mined in the Carlsbad Caverns until the 1920s when the caverns were declared a national park. Since this time, the caverns have attracted tourists to the area. In 1910, the Madison Well near Artesia was among the first to produce oil (Pratt 1989a:235). In the late 1920s, potash became one of the area's prominent industries. A major development in the oil and gas mining industry in this region came about with the formation of the E1 Paso Natural Gas Company in 1928. The Carlsbad Army Air Field was organized in June of 1942 as part of the World War II war effort (Pratt 1989b:267). More recently, the Waste Isolation Pilot Plant (WIPP) began operation in 1999. The WIPP site is in the underground salt beds southeast of Carlsbad. This facility is designed for disposal of transuranic radioactive waste.

3.9 LA 5148: Establishing a Temporal Context

LA 5148 is a large multi-component site whose artifact assemblages support an occupational range possibly starting in the early/middle Archaic period and terminating during the Protohistoric period. These occupations were in all likelihood, seasonal and short-term reflecting pulses in site use rather then continuous sedentary habitation. Using data presented in Runyan (1971), Haskell (1977), and Laumbach et al. (1979) a summary of chronometric evidence is provided below.

The Archaic period dates between 5500 B.C. and A.D. 500 and covers a wide temporal span, and surprisingly is represented by only a limited number of projectile points. Haskell (1977) reports on Archaic-age projectile points recovered from LA 5148 (ENM10017) possibly dating to the middle Archaic period (circa 4000 B.C.), while a Merserve variant was collected from ENM10032, which falls outside the Laguna Plata Archeological District. Other projectile point variants are identified as Tortugas, which has a temporal span of 800 to 600 B.C. (Turner and Hester 1993:188), Paisano variants which date between 200 B.C. and A.D. 600 (Turner and Hester 1993:165), Matamoros types, which are similar in form to the Tortugas variants generally occur after A.D. 200 (Turner and Hester 1993:153), and Ensor types (Leslie's type 8B) which date between A.D. 200 and 600 (Turner and Hester 1993:114; Shelley 1994:388). Leslie (1978) indicates 45 projectile points pre-dating A.D. 950 (Hueco phase) were collected from the site. An Archaic presence is suggested by the projectile point assemblage documented at the Laguna Plata site. However, what manifestation these occupations take is unclear. Moreover, to what extent do the typologies reflect site function and how accurate are chronometric parameters assigned to these artifact types are questions that need to be addressed.

The Formative period is much more salient, but no less complex. Previous excavations at the site collected a variety of Formative-age projectile point types, including Livermore (A.D. 900–1400), Harrell (A.D. 1100–1500), Fresno (post A.D. 900), Perdiz (A.D. 1200–1500), Leslie's Type 2B (A.D. 1200–1500), Type 3C (A.D. 1000–1200), Type 6B 6C (A.D. 850–1000), and Type 6C (A.D. 850–1000) (Laumbach et al. 1979). The age-range assigned to these point types indicates site use from A.D. 850–A.D. 1500. The ceramic assemblage is diverse with both locally identified pottery types associated with nonlocal variants (Figure 3.1). Thirteen pottery types were collected from LA 5148 and include brown wares: Jornada Brownware (A.D. 200–1350), South Pecos Brown (A.D. 900–1100), Roswell Brown (A.D. 200–1350), and McKenzie Brown (A.D. 1100–1300). Also documented are El Paso Brown (A.D. 200/400–1300) and El Paso Polychrome (A.D. 1200–1450). Pottery types reflecting nonlocal manufacturing include Mimbres Black-on-white (A.D. 850–1150), Three Rivers Red-on-terracotta (A.D. 1100–1300), Chupadero Black-on-white (A.D. 1100–1300), Ramos Polychrome (A.D. 1060–1519), Gila Polychrome (A.D. 1300–1400), Corona Corrugated (A.D. 1200–1460), and Lincoln Black-on-white (A.D. 1300–1400).

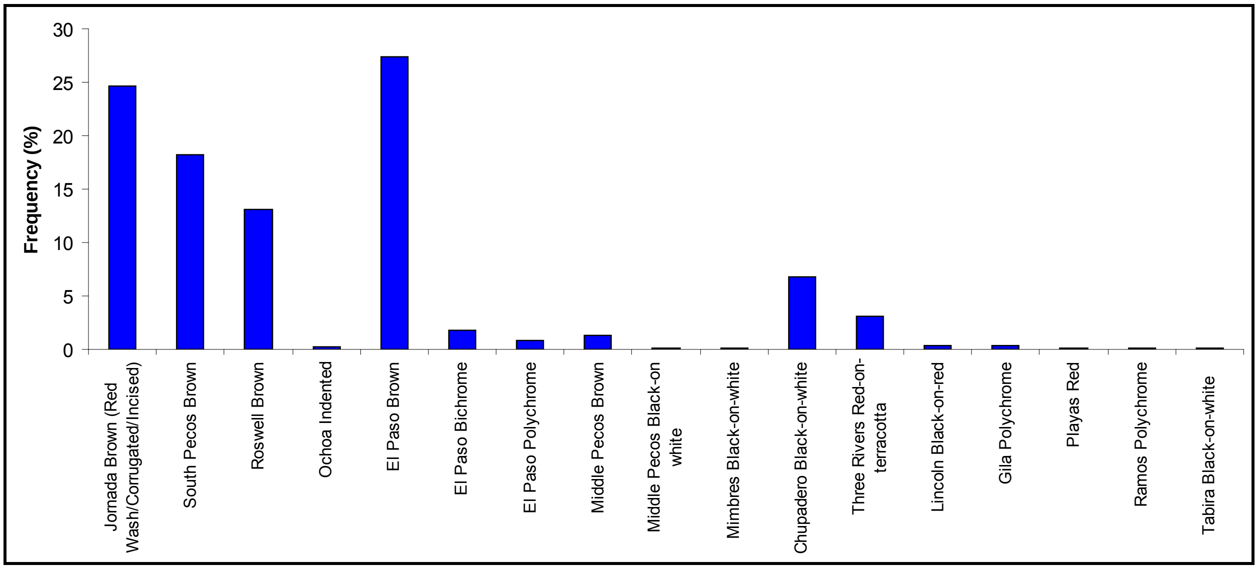

Figure 3.1 Bar graph presenting the comprehensive frequency percentage of ceramic types collected from LA 5148 (modified from Haskell (1977)

Using the artifact assemblage as the foundation to understanding the post A.D. 500 occupation at LA 5148, there are three periods of increased site use. The period between A.D. 200/400 and 1000 is represented by the highest pottery frequencies of any two combined ceramic types. Jornada Brown (24.6 percent/n=408) and South Pecos Brown (18.21 percent/n=302) comprise 42.81 percent of the ceramic assemblage (n=1,658) documented in Haskell (1977), which included collected sherds from the LCAS, Leslie, and ACA projects. The following pottery types (n=12) include both regional and extraregional ceramics and comprise a combined 55.21 percent (n=915) of the documented assemblage. Two pottery types, Ochoa Indented and Tabira Black-on-white, occur post-A.D. 1350 (0.36 percent/n=6). Both the projectile point and ceramic artifacts suggest extended occupations at LA 5148 that are punctuated by more intensive use between A.D. 200/400 and 1000 and again between A.D. 1000 and 1350. A near absence of site use is indicated after A.D. 1350.

These tentative age parameters are in keeping with current chronometric syntheses compiled by Railey, Rissetto, and Bandy (2009), which demonstrate more intensive occupation of the region starting about A.D. 200, peaking around A.D. 1000, and terminating around A.D. 1350. While there is some ambiguity to our comparison, it can be inferred that the period marking the highpoint of site use at LA 5148 occurred after A.D. 1000 and before 1350, with additional intensive site use between A.D. 200/400 and 1000. Moreover, the presence of Archaic projectile points along side pottery dating post A.D. 1350 further suggests LA 5148 experienced intermittent use during the Archaic and late Formative/Protohistoric periods.

4.0 Theoretical Orientation

Peter C. Condon

4.1 Research Design

The theoretical orientation for this testing project takes advantage of the opportunity to investigate LA 5148, a structurally diverse prehistoric site overlooking Laguna Plata playa in Lea County, New Mexico. This site is on the inner western margin of the saline playa, along an elevated terrace system that has yielded a range of cultural assemblages that includes two semi-rectangular pit houses, dense scatters of artifacts, and clearly delineated concentrations of artifacts, features, and culturally associated soil horizons. As a result, the cultural components may represent single or limited occupational events, and therefore provide an opportunity to examine cultural activities that have not been obscured or intermixed through time. Subsequently, the testing project stands to contribute to our understanding of prehistoric hunter-gatherer systems at the Laguna Plata site specifically, and to southeastern New Mexico in general.

The fundamental research objective of this testing project is to discern the location of the LCAS (1970 and 1971) and ENMU (1977) excavations and to re-examine Features 2 and 3, two possible pit houses excavated by LCAS. The second objective is to document and map features and artifacts across the landscape of LA 5148, in effect updating the archaeological manifestations at this locus. These two objectives provided the necessary data towards evaluating spatial diversity and land-use patterns at LA 5148 and correlating these data to current models of prehistoric mobility and adaptation. The ultimate value of this project is to provide data that will facilitate targeting future research efforts and data recovery strategies at LA 5148 and at other similar sites in the region.

4.2 Theoretical Framework: Explanatory Statement

This archaeological research program is guided by several assumptions. First, the construct of culture incorporates a complex set of rules or systems of knowledge that integrate “an extrasomatic adaptive system that is employed in the interaction of a society with its environment and with other sociopolitical systems” (Binford 1965:205). As a result, a cultural system can be characterized by a system of reference to its structure and organization. The structure of a system derives from the number, distribution, and arrangement of its components at a given point in time. The patterned interaction among these components constitutes the organization of the system (Clarke 1968; Owens 2003).

The fundamental theme underlying the construct of extrasomatic adaptive systems is that social systems are analogous to biological systems (Cadwallader 1980). Both organisms and societies are defined by “a system that exchanges matter with its environment, presenting import and export, and consequently, the building-up and breaking-down of its components” (Miller 1978:141). This organizational structure maintains a dynamic equilibrium that establishes an approximation of harmony between inflow and outflow with the environment (Miller 1978). The inability to maintain this balance results in the extinction of an organism or the failure of a culture to survive. Therefore, culture as a complex adaptive system may remain stable or change at varying rates depending on the overall balance of the human ecosystem. Subsequently, a series of regulatory mechanisms are developed that enable the transfer of energy from the environment into the social sphere of the cultural system. The emphasis on integration of culture and environment is considered to be of fundamental importance in understanding the structure and organization of hunter-gatherer societies. In fact, the exploitation and distribution of resources (i.e., available energy) acts as a primary determinant in the distribution of populations across the landscape (Kelly 1983).

The systematic movement of populations, and consequently, material goods, across a landscape is a behavioral characteristic that entails a significant investment of energy, and therefore, must result in a substantial benefit with regard to fitness (e.g., caloric investment). As a result, the selection of mobility, subsistence, and settlement strategies is based on a balance between success and failure. These management systems or resource strategies can be calculated within two opposing models of biotic variability: predictable versus unpredictable environments (Neff 1992:142).

Within predictable or congruent environments, the selection and acquisition of resources supports the development of centralized specialization (i.e., craft specialization, ceramic production) and economic exchange (i.e., complex political systems, systematic regional interaction) as population density increases within a given region. In contrast, unpredictable or incongruent environments (patchy resource distribution) will create systems oriented towards the organization of smaller population groups (Kelly 1995) (Figure 4.1). Smaller population groups use exchange as one of several loose-knit mechanisms that optimize resource acquisition. Other strategies that increase economic success for a population are migration, increased mobility and the exploitation of a broad resource base, and maintenance of a widespread network of social interaction (Neff 1992:141). Patterning of site locations and assemblage variability suggests by A.D. 1100/1200, several factors, including population increase and severe fluctuations in precipitation, resulted in a shift in mobility strategies, resource acquisition, and site location within the Laguna Plata region.

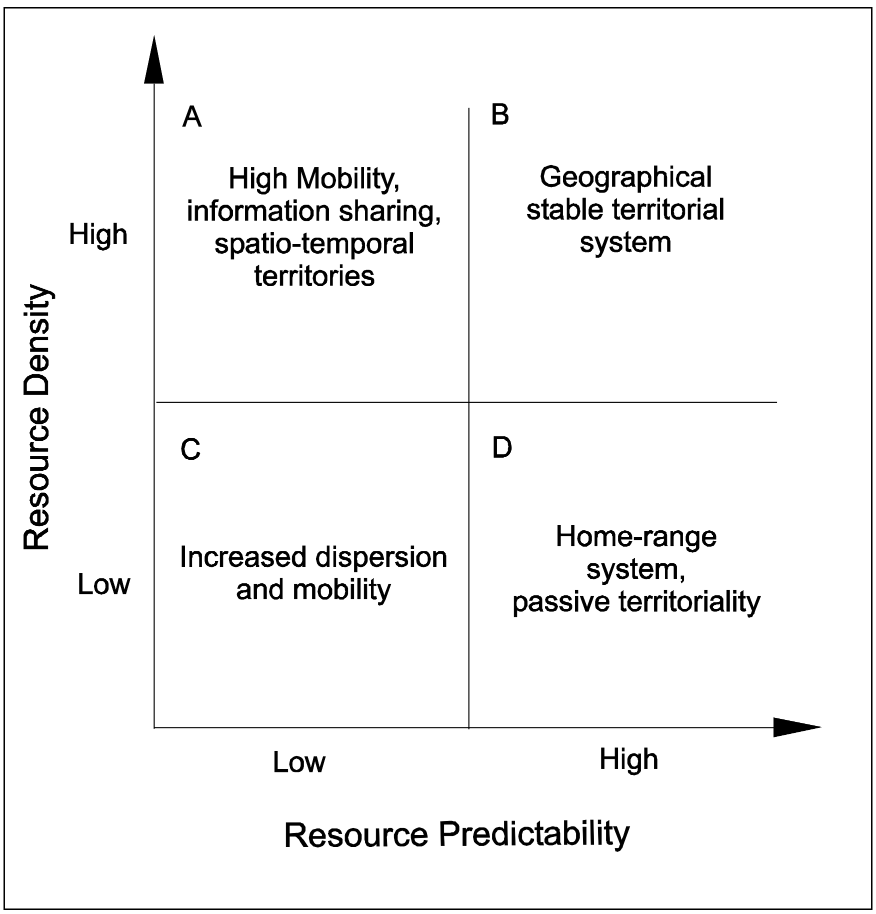

Figure 4.1 Adaptive strategies based on resource predictability and resource density (modified from Kelly 1995:190, Figure 5-4)

4.3 Models of Hunter–Gatherer Adaptation: The Forager-Collector Continuum

Identifying subsistence and settlement strategies represents the initial stage of interpreting hunter-gather adaptations within the Laguna Plata region. Understanding how and why cultures change is a primary goal of archaeological research, however, the ability to evaluate culture change over time is dependent on the ability to identify organizational systems at specific points in time. Therefore, identifying and understanding cultural variability at a given point along a time continuum must be achieved before temporal variation can be measured (Binford 1980).

Hunter-gatherer societies, which characterize much of southeastern New Mexico, are generally characterized by less complex organizational systems and tend to exhibit less status differentiation, lower population levels, and smaller population centers (Lee and DeVore 1976). The adaptive strategies of hunter-gatherer groups are more oriented to the distribution of natural resources and are more likely to manifest in a form that will maximize resource acquisition, such as increased mobility or the development of trade and exchange networks.

The scheduling and nature of resource acquisition depends on the regional extent and spatial structure of the selected resource(s), and the seasonality and temporal extent of resource availability. In regions where resources are abundant and available on a year-round basis, hunting-and-gathering groups can, theoretically, operate without a complex system of scheduling resource acquisition. As population increases or as resources become more limited, different strategies are required for the group to remain economically self-sufficient (Testart 1982). In areas with low resource productivity and/or irregular availability, complex scheduling of group foraging activities may be necessary to obtain resources during the entire year (Kelly 1983). Ultimately, hunter-gatherer groups can be characterized along a continuum ranging from forager-oriented on one end of the spectrum to collector-oriented on the other (Binford 1980; Kelly 1983).

Binford's (1980) forager and collectors organizational systems reflect differential use of the environment as expressed through mobility strategies. Within his model, two primary mobility strategies are presented: 1) residential and 2) logistical. Residential mobility is equated with high mobile foraging where family groups move from one resource patch to another and where an immediate-return economy is practiced. Ethnographically, this mobility strategy appears to be most effective when resources are congruent, predictable, and diverse (Binford 1980; Doleman 2005; Vierra and Doleman 1994; Yellen 1977). As residential sites are expected to reflect all activities associated with subsistence and settlement, including the terminal focus of procurement, consumption, and maintenance, the archaeological record is expected to be saliently visible and diverse.

In contrast, collector organizational systems are associated with the movement of individuals or small groups from a residential base camp for task-specific activities exemplified by specific plant procurement or opportunistic hunting. Resources are obtained, not for individual consumption, but for the greater community. A delayed-economic strategy is correlated with logistical/collector mobility strategies. This strategy has been ethnographically associated during periods when resources are incongruent, unpredictable, and scarce. As logistical sites are expected to be task-specific and of short duration, the archaeological record is expected to be vague and limited in the extent of activities carried out at a given locale.

4.4 The Cultural Ecology Approach

Contemporary with current theoretical models defining cultural adaptation and human behavior is an evolutionary or cultural ecology paradigm (Bettinger 1991; Butzer 1982; Krebs and Davies 1997). This theoretical paradigm is based on models of behavioral ecology first introduced by Julian Steward (1955), who formulated the theoretical framework of environmental ecology to identify patterns in social organization. Steward's (1955) pioneering interpretations have since been modified by Butzer (1982), Dunnel (1996), Rindos (1984), and Winterhalder and Goland (1997). As a result, cultural ecology is a diversified field of inquiry that draws upon numerous disciplines, including the social sciences, biology, economics, ecology, and geography. Although models of cultural ecology are ultimately founded on evolutionary principles, they generally do not examine evolutionary origins directly, nor do they directly monitor changes in the cultural analogy of gene frequency through time, at least when applied directly to archaeological data (Bamforth 2002). Since models of cultural ecology are not time transgressive, a synchronic approach to human behavior and adaptive strategies as they relate to cultural and natural environments is the theoretical framework for this project.

The cultural ecology approach focuses on the adaptive relationships of a culture or group to its environment (Anderson 1974; Butzer 1982; Helm 1962; Vayda and Rappaport 1968). In short, the cultural ecology position asserts that human populations possess problem-solving abilities that manifest at various levels including physiological, morphological, and behavioral (Boone et al. 1998). These problem-solving abilities, or adaptive strategies, represent a series of fitness-enhancing behavioral responses to varying environmental scenarios (Boone et al. 1998).

Three interrelated components of the human ecosystem provide the primary framework for interpreting human adaptation within the confines of the northern Chihuahuan Desert: 1) human populations as a biological phenomenon, 2) the opportunities and constraints offered by the available resources, and 3) the strategies adapted by cultural systems that enable them to survive on a collective level. Each of these three components is comprised of subcomponents that must be taken into account. In general, populations reflect adaptive diversity and evolutionary success by their relative size. Populations that exhibit growth are generally associated with favorable exploitation of the environment. In contrast, populations in decline symbolize a lack of social organization and successful resource gathering, commonly resulting in a decrease in overall population size. The systemic nature of social organization is further reflected in where and how a population chooses to exploit the landscape. This generalization implies that all behaviors will either be successful or unsuccessful. In fact, the evolutionary process operates on a separation between the rate of environmental change and biological change. Evolution can only work within a generational time frame, but the environment can change instantaneously. The success of human populations is dependent on the optimization of available resources, and minimizing cost and expenditure of time and energy. Among the interrelated systems that affect this cost-benefit ratio are technology, mobility, settlement and subsistence strategies, and ultimately, the ability to adapt to environmental change (Bettinger 1980; Butzer 1982; Clarke 1968).

In archaeology, especially concerning prehistoric hunter-gatherers, the more abstract social and cognitive dimensions of cultural systems tend to be very difficult to discern, but it is not theoretically impossible to do so. The environment is both spatially heterogeneous and temporally dynamic. The spatial availability of resources provides a population with opportunities, as well as constraints, and ultimately guides cultural adaptation. The predictability and concentration or patchiness of resources strongly influences the timing, size, and location of socioeconomic groupings of hunter-gatherers operating with more or less limited extraction, processing, and transportation technologies. Patterns of settlement and socioeconomic organization are thus closely linked with spatial and seasonal patterns of resource availability. Consequently, the assumption underlying organizational approaches to explaining cultural variability is that humans seek to maximize certain resources in response to environmental conditions (Bettinger 1980). Further, most applications assume that net energetic efficiency in foraging is a valid proximate measure of fitness, and consequently is maximized by natural selection. This simple, reductionism approach suggests the allocation of time or energy is determined by the spatiotemporal structure of the system (Jochim 1989:106).

The foraging-collector continuum and the cultural ecology approach provide for the formulation of a series of research questions directly applicable to sites in southeastern New Mexico. However, the theoretical paradigms presented here provide the framework on which to base future, more extensive investigations, rather than the limited data recovered during the current testing program. To this end, these questions primarily concern resource availability and shifting land-use patterns over time and can be used to identify which adaptive strategies were utilized at the site. Using a pluralistic theoretical model, research questions are presented in the following section.

4.5 Regional Models of Interpretation

As previously discussed, the Archaic period in southeastern New Mexico encompasses a span of almost 6,000 years during which there is little evidence for long-term sedentism or reliable evidence of agricultural dependency (Fifield 1984; Shelley 1994). This interpretation is in keeping with interpretative models suggested by Katz and Katz (1985), Lord and Reynolds (1985), and Wiseman (2002) in which no major shifts in subsistence or settlement occur within the region despite major shifts in environmental stability. In contrast, the oscillation between a mixed-spectrum economy during periods of resource scarcity and an economy focused on large herd animals during periods of environmental stability and resource availability is suggested by Shelley (1994).

The Archaic period in southeastern New Mexico, although not well understood, is generalized as a broad-based, mixed-economy hunter-gatherer adaptation (Sebastian and Larralde 1989; Stuart and Gauthier 1984). This interpretation is in keeping with fluctuations in biotic availability and oscillations in climate during the 6,000-year span. Applegarth (1976) and Shelley (1994) characterize this period as pre-ceramic small game hunter-gatherers with no reliance on agriculture (Shelley 1994). In support of this interpretation, there is little evidence for sustained hunting of artiodactyls in the low-lying draws of the region. Doleman (2005) argues for large-scale residential mobility that encountered scheduling conflicts for resource acquisition during what he calls “bloom or bust” scenarios. This lifestyle would have forestalled the adaptation of agriculture in the region as precipitation and distances between adequate lands would have been too great or unpredictable to cultivate a plant species such as maize. Consequently, the general inability to accurately place Archaic populations across the landscape hinders our capacity to further model this vast time period.

The subsequent Formative period can be interpreted as a continuation of highly mobile, mixed-spectrum subsistence patterns that continues from the Archaic period with little change despite the introduction of the bow and arrow and pottery. However, the second half of the Formative period exhibits an increase in sedentism, a presumed increase in population, a reliance on domesticates, and an increase in regional interaction. Sites dating to this period (post-A.D. 1200) include Bloom Mound (Kelley 1984), the Henderson site (Rocek and Speth 1984), and the Fox Place (Wiseman 2002).

The Formative period as further defined by Hogan (2006) is generally characterized by the production of Jornada Brown ceramics, the limited presence of intrusive ceramic types, subterranean domestic structures (pit houses), the limited presence of cultigens, and an increase in sedentism. As such, a shift in group mobility and site structure that is punctuated by a presumed increase in population. Binford (1965) argues that the stimulus for domesticating plant species was the development of population density in excess of what could be supported in a particular region by hunter-gatherers. This disequilibrium between population and resources resulted in an increase in the need for social aggregation, and subsequently, social complexity (Cohen 1977).

Consequently, agriculture has been seen as offering such a significant and obvious economic advantage to hunter-gatherer populations that once the proper knowledge was introduced, the acceptance of the new economy would be axiomatic (Cohen 1977). While this premise may hold true for portions of the southwest, the resource diversity identified within, and adjacent to, southeastern New Mexico may have precluded the need for entrenched agriculture despite an assumed increase in regional population. As

LA 5148 contains evidence for multiple occupations and extended use during the Archaic and Formative periods, and based on their proximity to possible seasonal water sources afforded by spring activity and catchments such as Laguna Plata basin, it may provide data on short-term sedentism and potential use of horticulture as a supplemental subsistence strategy during the Late Archaic and early Formative periods.

Wills and Huckell (1994) argue for a model of complex mutualism that evolved between cultivation and foraging in the face of changing climate and unpredictable resource availability in a post-A.D. 200 world. This interpretation suggests a shift in food production was part of a wide-ranging pattern of residential intensity that was influenced by an incongruent resource base. The domestication of plants was, therefore, a survival tactic that implied that the return rate from cultigens greatly outweighed the economic value of low-quality plants commonly selected by foraging strategies.

Hard (1983) and Doleman (2005) offer an alternate model that suggests that despite increasing populations, hunter-gatherers continued in a mixed land-use pattern that shifted group location within the Trans-Pecos region. This land-use pattern is directly affected by seasonal orientation and resource availability. As a result, mobility is structured around a series of complex residential and logistical moves that provided access to resources that are distributed in a spatiotemporal fashion (Diehl 1997:254). Consequently, domestication of plant species offered a supplementary subsistence strategy that may have been used in a limited fashion to expand foraging opportunities, not necessarily as a response to resource stress (Hard 1983) and Doleman's (2005) model differs from Wills and Huckell's (1994) interpretation primarily in the causal factors underlying the advent, and use of domestication, as well as the duration and extent of sedentism during the early Formative period.

At the core of these two economic-based strategies are biotic variability and the selection of dominant cultural traits that enable or optimize survival along a graduated adaptive system. Interspecies competition and biotic variability are evidenced through population growth during the early Formative period (i.e., the start of aggregated population systems and complex social systems) and fluctuating climatic conditions (Grissino-Mayer et al. 1997). It is hypothesized that dominant cultural traits, in particular, seasonally oriented sedentism (e.g., logistical winter alluvial-fan use vs. residential summer basin use) developed during the early Ceramic period increased group fitness, offset extreme variations in environment and enabled the continued optimization of the biotic and cultural landscape.

Based on Hard's (1983) interpretation, a model of subsistence, settlement, and mobility is proposed for Archaic and the early through middle Formative period that supports a fluctuating continuum from residential to logistical mobility patterns. For the relevant Formative time frame, mobility and subsistence may be opportunistically modified by the limited use of domesticated plants (i.e., maize, beans, and squash). As such, the construct of a supplemental adaptive model will be evaluated through an evolutionary approach that seeks to identify and explain the adaptive relationships of a culture or group to its environment within a materialist framework.

5.0 Research Domains and Questions

Peter C. Condon

Southeastern New Mexico has experienced shifts in population aggregation and landscape use that more often than not are defined by ambiguity rather than clarity. Moreover, while surface manifestations are clearly discernable throughout the region, the broader understanding of how cultural systems relate to one another through time is problematic at best. The ability to analyze both new data sets and existing artifact assemblages within a localized area, such as the Laguna Plata site, may permit an evaluation of culture adjustment to environmental change on a diachronic level of analysis. While a regional scale interpretation is not possible at this scale of investigation, the examination of cultural and environmental changes on a temporally and environmentally comparable platform is achievable. The relationship between human behavior and the occupations will be examined with the objective of understanding the fundamental relationship between culture and environment as expressed at Laguna Plata.

Based on the previous excavation data and the artifact assemblages, it is assumed LA 5148 encompasses early Archaic through Late Archaic components, with greater site use between A.D. 600 and 1350. This interpretation is in keeping with the projectile point and ceramic assemblages documented by LCAS and ENMU-ACA, which suggests the local manufacturing of brownware variants in addition to trade and exchange with populations outside of the region. Haskell et al (1977) and Laumbach et al's (1979) interpretation that LA 5148 may reflect a seasonal residential site during the Formative period is in keeping with current models presented by Condon et al. (2008b).

The following research questions are guided by the theoretical perspectives presented in Chapter 4 and are based on the assumption that it is possible to interpret specific hunter-gatherer subsistence, settlement, and technological strategies through the use of archaeological and ethnographic data. The theoretical foundation proposed for this project is synthesized into a working model that has been proposed for the Trans-Pecos region by Diehl (1997) and Condon et al. (2008b). This model is most applicable towards sites that are likely to be Formative in age and of limited artifact density. As such, the following model examines land use and resource procurement at LA 5148 during the Archaic period, but with emphasis on the Formative interval of A.D. 600 to 1450.

Within the project area, which falls within the Laguna Plata Archaeological District, sites tend to manifest themselves as small, temporally vague occupations with relatively small assemblages and few diagnostic artifacts, punctuated by several large sites with assemblages and features positioned within large deflation basins (Laumbach et al. 1979). The unique positioning and characteristics associated with LA 5148 underlies the importance in studying this cultural phenomena in a more detailed manner. The research issues most critical to this project address human behavior, such as why hunter-gatherers occupied a particular landscape, what did hunter-gatherers exploit while occupying the landscape, and how did hunter-gatherers acquire and process resources across the landscape.

5.1 The Model: Bi-Seasonal Mobility Among Hunter-Gatherers

Traditional models of hunter-gatherer mobility and land-use strategies tend to encompass a range of external and internal factors that define the relationship between human behavior and the environment (Nelson and Schachner 2002:193). Following Binford's (1983; 2001) hunter-gatherer continuum, settlement strategies are classified as residential or logistical based on occupational longevity, site structure, and site function. In essence, populations that use residential, high mobility, land-use strategies "to move consumers to the resources" are classified as foragers. In contrast, populations that occupy more sedentary residential loci and bring resources to the consumers through logistical mobility strategies are referred by Binford (2001) as collectors. Where along this continuum a population falls is based largely on the diversity and availability of resources.

As argued by Binford (2001), pre-agricultural populations of the greater Southwest, in all likelihood, practiced a broad-based foraging spectrum that was seasonally oriented. Subsequently, settlement patterns would have been adjusted to offset season, climate, resource availability, and possibly other socio-economic demands. As such, there is considerable ambiguity in the use of these terms, and while residential should not be taken to mean permanent throughout a year, neither should short-term be taken to infer only one or two days. Further, while it is likely that sites with evidence of residential occupancy would include a generalized range of activities that would be expected at base camps, there is no need to expect that short-term occupations be functionally, or task specific.

Diehl (1997) on a localized level, suggested that hunter-gatherer groups occupying the project area pre-A.D. 1100 would have used a seasonally based residential mobility strategy that was influenced by warm and cold weather climate, resource abundance, and opportunistic regional interaction. Seasonal mobility would have focused on a two-season settlement model that positioned small-family groups within the low-lying basin during warm-weather months and aggregated populations along the alluvial fans during the cold-weather months.

5.2 Warm-Weather Settlement and Subsistence

According to Hard (1983) and Shelley (1994), small-family residential groups that moved from resource niche to resource niche exploiting an area until the biotic resources were dwindled or depleted would have characterized the settlement and subsistence patterns of the basin during the warm-weather months. These residential movements are best exemplified by a foraging mobility that used a single base camp in or near a primary resource area. Warm-weather residential camps would be characterized by low artifact density and low assemblage diversity. In addition, architectural elements expressed by shallow ephemeral pit structures may also provide a more salient reflection of residential occupation. These delineating attributes stand in contrast to logistical camps in which artifact density is extremely low and diversity is, at times, almost unidentifiable (Condon et al. 2006a, 2006b).

Binford’s (2001) hunter-gatherer continuum is further defined through ethnographic data. Based on modern foraging groups, such as the San and Hadza, food is gathered and processed for immediate consumption. These immediate-return economies tend to be associated with limited number populations, egalitarianism, and resource sharing. In contrast, collectors are often associated with a delayed-return economy, which is highlighted by investment in technology or labor that would produce future returns, provide storage, or increase the quality of successfully exploiting wild products (Kusimba 2005).

5.3 Cold-Weather Settlement and Subsistence

Settlement strategies during cold-weather months would have experienced major shifts in degree of mobility, location, and subsistence acquisition (Condon et al. 2008a, 2008b; Condon and Hermann 2009). As resources become regionally scarce and more spatially localized due to a decrease in annual precipitation and temperature, populations would have modified their social organization to adjust for a period of resource constraints. Three factors stand out with regard to cold-weather settlement: 1) small-family groups tend to aggregate into semi sedentary villages along the alluvial fans, 2) a delayed-return economic strategy in the form of fixed and transportable storage will be utilized, and 3) interregional social networks will be employed to help offset a decrease in resources. In effect, an increase in localized population and a decrease in mobility allows for trade and exchange to take place within the region on a scale that was not possible when populations are dispersed and highly mobile.

As argued by Binford (1980), group mobility would have been primarily defined as a logistical strategy that employed collecting select resources during daily or short-term forays away from the base camp. In this manner, hunter-gatherers would have brought resources back to the base camp without shifting the base camp locale (Binford 1980; Hard 1983). Cold-weather habitation sites would be exemplified by deep, well-constructed pit houses, high artifact densities, high assemblage diversity, storage pits, burials, and spatially discrete activity areas (Condon and Hermann 2009). In contrast to warm-weather habitations, cold-weather sites would also exhibit a higher frequency of non-local pottery types and intrusive artifacts (i.e., shell or turquoise).

To summarize, Early Archaic to middle Formative period hunter-gatherers practiced a high mobility settlement strategy during the warm-weather months as they moved from one resource area to another in search of food. The subsistence strategy emphasized an immediate-return economy that focused on plant and small game resources. In contrast, hunter-gatherers would have aggregated into larger communities during the cold-weather months and practiced a logistic mobility strategy, a delayed-return economy that stressed storage, and accelerated social interaction on an interregional basis. In addition, large game, such as deer or pronghorn, would have become more predictable and desirable and more valued as an exploitable resource.

5.4 Quantifying Chronology and Context

Chronometric analyses and stratigraphic context are two critical components to this project. Beyond establishing a temporal framework in which to evaluate the site, chronometric analyses will not be viewed as a research domain, but rather as a mechanism in which to quantify an occupation or activity. In a similar fashion, contextual integrity will not be implemented as a research issue. Context as interpreted through stratigraphic deposition, spatial patterning, and site-formation process will serve as a tool to determine the integrity of a particular cultural manifestation.

5.5 Settlement Research Issues

5.5.1 Early to Middle Archaic Period Settlement

Hunter-gatherers existing pre-3400 B.C. within the Laguna Plata region adjusted their resource selection and scheduling decisions on the seasonal availability of plant and animal species. According to Hard et al. (1996), Mauldin (1996), and Doleman (2005), Archaic groups would have moved across the region throughout the warm-weather months in residential groups exploiting a broad spectrum of resources that may have favored small mammals, grasses, and seed-bearing plants. During the winter months, these same residential groups may have moved along the alluvial fan margins acquiring larger game, accessing wood for fuel, and taking advantage of the numerous springs and playas located along the edges of the alluvial fans. Following this model, it is suggested that Early Archaic groups would have been dependent on a multifunctional tool kit that was highly portable, maintainable, and versatile. As such, the archaeological signature at Early Archaic sites will be relatively ephemeral. The ephemeral nature of the Early Archaic occupation will be characterized by small site size, low assemblage density, and low assemblage diversity that is due in part to high group mobility, a lack of population pressure, and an abundance of biotic resources.

5.5.1.1 Hypothesis 1:

Early Archaic settlement patterns at LA 5148 will reflect warm-weather occupations during which a mixed resource base would have been exploited. These components will be small in size, with a technological organization that focused on a biface-oriented reduction strategy. Ground stone technology will be minimally reflected within the Early Archaic component.

5.5.1.2 Expectations:

If this hypothesis holds true, then we would expect to find:

- Residential occupations of Early to middle-Archaic time frames will exhibit low artifact density and diversity, characterized by a biface-oriented reduction strategy.

- The presence of raw material derived from outside the region will indicate direct exploitation of resources.

- Ground stone artifacts will be present in the assemblage, but will occur in low frequencies.

- Projectile point manufacture and maintenance will be saliently exhibited. Hunting large game will play a more salient factor in basin occupation.

5.5.2 Early to Middle Formative Period Settlement

As noted by Hogan (2006)**,** the character of the basin's prehistoric record post-3400 B.C. appears to be also one of salient bi-seasonal adjustment motivated by increased aridity, cold and warm-weather seasons, divergent resource availability, and to a degree, increased population pressure. In much the same manner as the Early Archaic populations, early and middle Formative period population use of the basin during warm-weather months would have been characterized by residential mobility, a mixed-species subsistence based on seasonally available resources that emphasized an immediate-return economy during the height of resource abundance. As temperatures start to decrease and resources are in decline, however, the settlement strategies shift towards short-term sedentism in the form of larger base camps along the alluvial fans. Resource acquisition will highlight logistical mobility in which small groups of hunter-gatherers would move along the upper alluvial fans and also down into the basin for localized resources. This shift in resource selection that would include large mammals, would take advantage of close proximity to the mountain ranges and the predictable nature of artiodactyls during the fall and winter months. In contrast to Archaic settlement strategies, early and middle Formative settlement would have experienced aggregated populations, the use of large, well-constructed structures during cold-weather months, fixed and transportable storage, increased territorialism, and the use of social networks as a means to offset inclement weather and decreased resource availability.

5.5.2.1 Hypothesis 2:

Early and middle Formative period use of LA 5148 will also exhibit evidence for a warm-weather, residential pattern of mobility. These occupations may exhibit use of ephemeral shelters, increased assemblage density and diversity, and increased frequency in ground stone artifacts.

5.5.2.2 Expectations:

If this hypothesis holds true, then we would expect to find:

- Residential occupations of early to middle Formative time frames will exhibit increased artifact density and diversity supporting the hypothesis that multiple activities were carried out.

- Residential occupations will contain evidence of architecture in the form of ephemeral semi-subterranean structures. Based on sites of similar age, architecture will be of shallow basin-shaped floor plans and measure less than 12.10 m^2 in area (Condon and Hermann 2008; Graves et al. 1996; Wiseman 2003; Zamora 2000).

- Although flaked-stone technologies may exhibit both bifacial and core/flake trajectories, the tool manufacturing process will be dominated by a core/flake reduction strategy (i.e., broad based, resource abundant). Biface reduction strategies will be limited to maintenance and retooling, not manufacture. Hunting large game will not play a major factor in basin occupation.

- As the exploitation of seeds may increase during the Formative period, ground stone artifacts will be present in greater frequencies.

- Pottery will be associated with early Formative period occupations, however, large storage pots or storage pits will not occur. Fixed storage technologies will not play a critical factor in an immediate-return economy. In contrast, smaller, transportable storage in the form of multifunctional tecomates or shoulderless jars will occur with the greatest frequency with residential occupations.

- Nonlocal pottery will not occur with any regularity or frequency. The absence or near absence of intrusive pottery will support the interpretation that regional interaction will be at its lowest occurrence when populations experience their highest mobility rates.

5.5.2.3 Data Analysis

Spatial examination of LA 5148, as well as analysis of the cultural assemblages, may present a means of evaluating the multicausal factors of site selection and abandonment. Settlement patterns should be amenable to archaeological explication. By shifting the perspective from a narrow approach to a broader interpretative strategy, we may be able to hypothesize not only about settlement and abandonment patterning, but also about subsistence activity and possibly demographic trends (Shelley 1994).

The arrangement of cultural material within a site is referred to as community patterning and reflects the intrasite relationship, or spatial patterning, between the natural setting, artifacts, and features. One of the most elementary questions that can be asked is whether this patterning can be discerned. Region wide studies demonstrate that there is only limited data substantiating the concept of internal site patterning for the Jornada Mogollon region. Patterns of internal use for small campsites are limited, with some researchers suggesting camp activities appear to be “feature-focused” (Condon 2002; Wiseman 2003; Zamora 2000).

Another complicating factor in the identification of community patterns is the intermixing of cultural deposits. As with many of the prehistoric sites in the region, LA 5148 may have evidence of multiple occupations within deposits that are rarely more than a few centimeters in depth. Sediments containing multiple components have often eroded deposited cultural material from many different occupations on a single surface. Additionally, frequent material scavenging and reuse of favored locations complicate efforts to discern individual components.

Detailed mapping of features and artifacts will be used to discern community patterns. The nature of feature distributions and artifact clustering is elemental to the discovery of activity areas and discard patterns that, in turn, help interpret how a site was organized. The identification of spatially discrete horizontal and vertical components is required. The presence of intrasite relationships can be discerned by chronological dating of specific features and artifact clusters and by comparing and contrasting intrasite loci.

Additionally, LA 5148 may exhibit a complex overlay of repeated occupations over thousands of years; some of the occupations may have been short term and others residential. The overlapping of occupational episodes at this site poses a difficult problem to overcome. However, if contextual and spatial integrity has been maintained, then identification of social organization can be attempted. By integrating assemblage composition and pattern recognition strategies, an analysis of Archaic and early Formative settlement strategies can be accomplished.

5.6 Subsistence Hypothesis

5.6.1 Early to Middle Archaic Subsistence

Early to Middle Archaic subsistence patterns within the project area are not well established due to a lack of data from the first half of this period (Doleman 2005; Shelley 1994; Vierra 1994). In a review of Archaic subsistence data (Miller 2007; Shelley 1994), we can identify two subsistence patterns for the region. The first is characterized as a focal subsistence pattern oriented towards large game procurement from upland settings. Based on the faunal assemblages documented at Fresnal Rock shelter, Fallen Pine Rock shelter, and High Rolls cave, it is assumed artiodactyls (e.g., *Odocoileus hemionus*, mule deer; *Antilocapra americana*, pronghorn) played a significant resource factor, or at least a more obvious one with regard to preservation, when compared to open air sites of similar temporal settings (Miller 2007). Upland resources would reflect cold-weather occupations that exploited artiodactyl species when they were more predictable.

Small-game hunting and plant gathering within the basin environments characterize the second subsistence pattern. Within this model, there is little evidence for the hunting of artiodactyls, only preliminary evidence for ground stone technology and seed processing, and an indication that occupational longevity is based on resource availability and diversity (Shelley 1994). Subsequently, a mixed-resource strategy that highlighted small game, roots, berries, and edible plants found within exploitable regions of the basin appears to reflect a shifting warm-weather subsistence pattern for Early and Middle Archaic populations using the basin environment.

5.6.1.1 Hypothesis 1:

Early to middle Archaic use of LA 5148 will reflect a seasonal extractive subsistence strategy that exploited a variety of resources, highlighted by small game and nonseed-bearing plant species.

5.6.1.2 Expectations:

If this hypothesis holds true as Shelley (1994) and Vierra and Doleman (1994) propose, then we would expect to find:

- Early and middle Archaic occupations will exhibit a mixed-subsistence economy in which small game, such as black-tailed jackrabbit (*Lepus californicus*) and desert cottontail (*Sylvilagus audubonii*) were favored.

- As a result of seasonal availability, artiodactyls will occur infrequently within the Archaic archaeological record.

- According to Adams (1999), ground stone size, morphology, and use will support the interpretation that basin hunter-gatherers focused on small game and a broad spectrum of floral resources. Within the floral resource base, seeds and other nonperishable species will not figure prominently.

5.6.2 Early to Middle Formative Subsistence

Hunter-gatherers of the early and middle Formative period had to adjust their resource selection and scheduling to a seasonally diminishing biotic selection whose abundance was determinant, in part, on diminishing annual precipitation. As such, during the summer rainy seasons, floral resources would be more available and basin exploitation would have experienced its greatest activity. Based on current floral availability, it is expected that mesquite beans and seeds from acacia, yucca, amaranth, chenopod, sunflower, and drop seed would have provided a food source that could have been consumed immediately after processing or stored for future use. Artiodactyls would have also provided an infrequent food source along the uplands and basin margins; however, within the basin proper, small game, such as cottontail or jackrabbit would have been the most available. Undoubtedly, changes in basin exploitation over the last 3,000 years can be accounted for by the relationship between climate, resource diversity, and population pressure. Major transitions from a mixed-resource economy that exploited a broad spectrum of seasonally based resources, however, are gradual in nature and ephemerally present in the archaeological record. Several characteristics of Formative period subsistence strategies are more expressive than others. For instance, the increased value of seed-bearing plants is evidenced by increased frequencies of ground stone implements. Storage, both transportable (e.g., jars and baskets) and fixed (e.g., storage pits) infer that nonperishable resources were becoming increasingly important as a means of delayed-economic return in anticipation of cold-weather resource scarcity.

5.6.2.1 Hypothesis 1:

Due in part to increased aridity and population pressure, early to middle Formative period use of LA 5148 will reflect broad-spectrum resource acquisition of perishable and nonperishable resources that are reflected in the seasonal exploitation of small game and seed-bearing plant species.

5.6.2.2 Expectations:

If this hypothesis holds true as Hard (1983), Condon et al. (2006a, 2006b), and Condon et al. (2008b) propose, then we would expect to find:

- Residential occupations of the early to middle Formative period will exhibit increased resource diversity in which a broad spectrum of plants would have been exploited.
- As a result of increased aridity, artiodactyls will occur infrequently within the basin archaeological record, while small herbivores will emerge as a prominent exploitable resource.
- According to Adams (1999), ground stone size, morphology, and use will support the interpretation that basin hunter-gatherers focused on small game and a broad spectrum of seed-bearing floral resources. Within the floral resource base, seeds and other nonperishable species would figure prominently.
- Pottery associated with early Formative period occupations will reflect jar vessel forms in which resources can be cooked, boiled, or stored.

5.6.2.3 Data Analysis

The identification of subsistence resources will require the recovery of plant and animal remains through the systematic collection of large-volume soil samples for flotation. In addition, the description and analysis of tool and feature form and function should be undertaken to support any direct organic evidence that may be recovered. Artifacts, burned rocks, and features from “sealed” contexts, which are ideal for preserving minute traces of residues and other organic material, will be sought.

Macrobotanical and pollen evidence collected from various site contexts, including feature and nonfeature contexts, will be analyzed. Data from discrete stratigraphic contexts (e.g., intact features, securely dated sediment zones) will provide the primary basis for reconstructing the subsistence base, but samples from less discrete contexts (e.g., general sediment zones) may nonetheless provide significant supporting evidence. In addition, residues on ground stone tools should provide a direct measure of the range of resources processed with ground stone technology.

Faunal remains from site features, as well as from less discrete site contexts, will be analyzed. Macroscopic data, such as faunal remains and shell, represent the best sources for evaluating the range of potential animal resources in the prehistoric diet. Analyses of faunal remains can also contribute to the formulation of hypotheses about procurement and processing strategies, discard patterns, and secondary uses of faunal raw materials. Identification of faunal and floral resources will also be attempted through lipid residue extraction analysis from burned rock, flaked-stone tools, and ceramic sherds. It has been demonstrated that organic residue can be extracted from burned rocks and pottery from regional sites (Condon et al. 2007; Quigg et al. 2001). This proxy line of investigation is critical when chemical and environmental conditions are not conducive to the preservation of organic data like faunal and floral remains and in older deposits where organic preservation is poor.

Analyses of stone-tool variability may contribute information on subsistence extraction and processing that can be used to help reconstruct the subsistence base. The presence or absence and relative proportion of certain tool forms indirectly suggests the subsistence practices. While tool-assemblage variability is more directly associated with procurement and processing strategies, some analytical results may lend themselves to reconstructing subsistence.

5.7 Technology Hypothesis

Of equal importance to understanding settlement and subsistence strategies within the biseasonal model is how hunter-gatherers use technology to aid in resource acquisition and processing. Technology, briefly defined by Binford (1980), is the use of knowledge and application in the form of tools that aid a species in adapting to an environment. This definition is limited in expression and complexity; however, for this project, this interpretation will suffice. As such, technology can take on many forms; however, for this project technology will be addressed through an analysis of lithic-reduction strategies, ground stone morphology and use, ceramic vessel form, and feature construction, distribution, and implied use.

With regard to interpreting the organization of technology, there is a consensus that wide varieties of factors account for tool manufacturing variability (Nelson 1991; Sellet 2006; Torrence 1994). Among the factors are group mobility, resource selection, resource abundance, and acquisition scheduling. In an attempt to contextualize technology in a basin environment, the anticipation of resource needs and expectations, as well as reduction strategies in the face of climate and resource availability becomes a critical component towards archaeological inquiry (Sellet 2006). Typically, an examination of technology is undertaken through the analysis and descriptive summary of the transformed raw materials, such as flaked stone, ground stone, and ceramics. Analysis may focus on temporal changes, morphology, production technique, and reuse strategies (Abbott et al. 1996; Kooyman 2002; Odell 2004). From these data, inferences can then be made regarding the activities that created the artifacts and the importance of the activities to subsistence and cultural foundations within populations.

5.7.1 Early to Middle Archaic Technology

Within current operating models of hunter-gatherer settlement and subsistence, technology is viewed as an immediate response to mobility and resource availability. With this in mind, the organization of technology during the early and middle Archaic periods would have centered on a biface reduction strategy that was underlined by a more expedient core/flake technology. Flaked-stone technology appears to be characterized by at least two attributes: 1) a general continuation of a biface-oriented core reduction strategy that produced relatively large stemmed bifaces, and 2) a noticeable decrease in maintenance, durability, and possible versatility within Archaic projectile point assemblages when compared to earlier periods. As discussed previously, the inclusion of ground stone in the early and middle Archaic tool kit does not seem a high priority during the first half of the Archaic.

5.7.1.1 Hypothesis 1:

During periods of resource congruence and abundance, early to middle Archaic hunter-gatherers occupying the basin will exhibit a tool kit composed of multifunctional flaked-stone tools indicative of a bifacial-reduction strategy used to exploit a mixed-resource base and take advantage of opportunistic hunting of artiodactyls when encountered.

5.7.1.2 Expectations:

If these hypotheses hold true as Hard (1983), Wiseman (2002), and Condon et al. (2008b) propose, then we would expect to find:

- Residential occupations of LA 5148 during the early to middle Archaic period will reflect tool manufacture and maintenance centered on hafted biface production rejuvenation. Assemblages will include bifacial cores, lithic debitage of late trajectories, and discarded flaked-stone tools.

- Residential occupations of LA 5148 during the Early to Middle Archaic will exhibit by the use of locally available tool stone, but with moderately high occurrence of nonlocal tool stone as well.

- Ground stone technology will reflect the use of relatively small, slab metates that will exhibit minimal to moderate modification and occur in low frequencies in the artifact assemblage.

5.7.2 Early to Middle Formative Technology

Condon et al. (2008b) suggest that resource availability within LA 5148 and adjacent regions reinforces the continuation of a core/flake technology. It is further suggested that this generalized technological response shifts in emphasis from a multidirectional core reducing strategy to include a form of formal expediency most prevalent post-A.D. 400. Formal expediency focuses on a unidirectional or bidirectional reduction trajectory from prepared cores and appears most saliently when three factors merge. These factors are: 1) abundance in tool stone, 2) tool stone in the form of a cobble or rounded morphology, and 3) access to relatively small plant and animal resources.

Andrefsky (1998) argues for increased emphasis on expedient tool forms within regions where tool stone is readily available. Considering this, the Mescalero Escarpment alluvial fans bordering the project area provide an abundance of tool stone from the eroding Ogallala gravels that is both accessible and knappable. Subsequently, if tool stone surrounds hunter-gatherers, curation and carrying capacity should not play a critical role in selecting tool technology for mobile populations. Formal tools, which are broadly defined as modified flakes or cores that exhibit extensive retouch or continued use-wear through episodes of maintenance, resharpening, and repair should occur with frequency at LA 5148. Therefore, in the advent of lithic abundance, only stone morphology and function should play a major part in determining reduction strategies within the low-lying basin environment. The morphology of the local stone is predominantly rounded and of cobble size, therefore, one would not expect large bifaces to be a common occurrence. The limited modification of core-flakes would be the anticipated tool type encountered in the basin. An emphasis on core/flake reduction strategies and minimally modified flakes will be the primary flaked-stone technology identified at LA 5148. Flaked-stone tools that exhibit minimal use-wear and limited shape development also experience a limited life span. Such tools generally serve an immediate, limited function and are then discarded. Consequently, analysis of debitage, and tool form and function, may isolate specific techniques and technologies associated with task-specific activities.

The presence of ground stone on prehistoric sites within the basin is often used as a proxy measure for specific processing activities. Current research, as well as ethnographic documentation, has provided evidence for the use of ground stone as a determinate of agriculture and nonagricultural food processing. Analyses of ground stone attributes may provide insight into what types of nondomesticated resources were being processed and what types of food collection strategies were being carried out in the basin. Specifically, morphological attributes can be temporally identified within a region and examined for size, use-wear patterns, and material type. Additional analyses involving starch grain and FTIR residue testing may also provide data on selection and processing.

Within the context of this testing program, an understanding on where pottery types were manufactured as well as vessel form and type will be addressed. Under the first research issue, INAA analysis will be conducted on a variety of pottery types collected from LA 5148. This analysis will provide insight into possible manufacturing scenarios and a comparative database by which LA 5148 samples can be examined. Vessel form provides a means to investigate function and mobility. With vessel form, we infer that due to high mobility use of the basin area, pottery would operate as a functional cooking mechanism and as a means of transportable storage.

The duality of purpose also suggests smaller nonperishable food items, such as seeds as well as dried maize, may have played a vital role in supporting a delayed-return economy of a population during the cold-weather months. Vessel type focuses on the presence or absence of nonlocal pottery types. As network systems are an implied approach to offsetting resource incongruence through trade and exchange, reciprocity, and boundary establishment, it is expected that during times of decreased resource availability, interaction on a interregional level will substantially increase. In contrast, during the warm-weather months, when family groups are segregated and resources are abundant, social interaction would occur primarily on an intraregional level with passive territorialism (Dyson-Hudson and Smith 1978; Kelly 1995). Under this assumption, nonlocal pottery type should occur in elevated frequencies at residential sites that serve as a focal point for trade and exchange. The Laguna Plata site is situated between the Pecos River valley and the Southern High Plains, providing an opportune locus for interaction between populations.

Feature morphology, matrix, and distribution can also provide avenues of interpretation for basin activities. Morphological attributes, including size, composition, and design, contribute to identifying function and developing a more accurate assessment of resource exploitation. Feature deposits may contain remnants of processed animals and plants, which can offer invaluable data towards testing and revising subsistence and settlement models.

Other features, by their presence or absence, also can be used to infer activity and occupational patterns. For example, the presence of middens, which are identified in the northern portion of LA 5148, is commonly used to support arguments of long-term use of a site. The artifact assemblage may also help to define activities performed. Data regarding seasonality of occupation may also provide information about patterns of land use and length of occupation. Landscape information, such as the topographic setting, the proximity of important landscape features such as playas, and the presence of particular subsistence resources will help define what role LA 5148 has in the overall land-use pattern.

5.7.2.1 Hypothesis 1:

During periods of resource congruence and abundance, Formative-age groups will exhibit a tool kit composed of multifunctional flaked-stone tools indicative of a core/flake reduction strategy used to exploit a mixed-resource base.

5.7.2.2 Hypothesis 2:

In the face of lithic abundance, as noted within and around the basin environment, we expect to encounter a multidirectional approach emphasizing a series of reduction strategies with regard to tool manufacture. The technological reduction strategies represent one element in an array of cultural adjustments that focused on available resources and reflect a form of tool expediency.

5.7.2.3 Hypothesis 3:

Lithic resources consist primarily of small-sized resources, consequently, hunter-gatherer groups will use informal slab metates and cobble manos to process both faunal and floral resources common to the basin. The availability of sandstone outcrops at LA 5148 will provide the primary material for ground stone manufacture.

5.7.2.4 Hypothesis 4:

Ceramics identified within early Formative components will be comprised exclusively of jar vessel forms that serve both cooking and transportable storage functions.

5.7.2.5 Hypothesis 5:

Feature morphology and construction will reflect informal pit structures and limited-use domestic hearths rather than formal rock-lined pits or annular rock-ring roasting pits.

5.7.2.6 Expectations:

If these hypotheses hold true as Condon et al. (2008b) propose, then we would expect to find:

- Residential occupations at LA 5148 during the early to middle Formative will reflect the full range of tool production. Assemblages will include cores, lithic debitage of all trajectories, and discarded flaked-stone tools.

- Subsequent to the first expectation, core reduction will reflect an emphasis on expedient core preparation, multiple platforms and flake removals, and a less formalized reduction strategy.

- As hunting large mammals (*Bison bison*) is an activity associated with LA 5148, bifacial reduction strategies will be of significant importance and expressed through manufacture and maintenance.

- Residential occupations of the basin during the early to middle Formative will be dominated by the use of locally available tool stone.

- Residential occupations of the basin during the early to middle Formative will reflect an emphasis on minimally modified or unmodified tools.

- Ground stone technology will reflect the use of small slab metates that will exhibit minimal to moderate modification.

- Pottery associated with early Formative period occupations will reflect jar vessel forms in which resources can be cooked, boiled, or stored.

5.7.2.7 Data Analysis

A descriptive summary of all material culture, using developed methods, is one of the primary means of investigation. Spatial analysis of artifact and feature distributions will also assist these efforts. Select geochemical and compositional analysis of artifacts and features will be used to identify source origins and to trace the movement of objects across space. The generation and evaluation of artifact indices, such as the ratio of formal tools to debitage, or ground stone to fire-cracked rock, will be used to examine functional variability within the site. Thin sections taken from ceramic artifacts will be needed as part of the analysis of pottery technology and production techniques.

5.8 Intraregional and Interregional Interaction Hypothesis

Ethnographic data documents that hunter-gatherer populations share food, goods, and access to territory on a cross-regional basis (Binford 1989; Radcliffe-Brown 1930; Steward 1936; Yellen 1977). The cost and benefits of intra-and interregional interaction are not based in simple altruism, but on a more complex system of demands that, in part, are instigated by resource availability and risk minimization. For example, Cashdan (1984) suggests during periods of high resource density and moderate to low predictability, such as experienced in the seasonal rounds of basin environments, hunter-gatherer groups will be highly mobile with intraregional information sharing occurring commonly (Kelly 1995). In contrast, during periods of low resource density and moderate to high rates of predictability, hunter-gatherers will adjust with low mobility, increased interregional social ties, including reciprocity as a means of insuring against starvation (Kelly 1995). To this end, the following hypothesis is presented:

5.8.1.1 Hypothesis 1:

During periods of prolonged residential occupation and seasonal resource incongruence, foraging groups will exhibit elevated inter-regional interaction, resulting in a moderate to high presence of nonlocal artifact types.

5.8.1.2 Expectations:

Using the bi-seasonal mobility model, we can expect:

- The cost and benefits of interregional interaction will be expressed by increased levels of regional interaction. Nonlocal pottery types or exotic artifact types will be present.

- The cost of intraregional communication will be low and the return of valuable resources will be high. Conceptualizing this expectation in the archaeological record will be difficult, since the commodity being shared is most likely information and not a more tangible form of trade or exchange.

- Based on the climatic and archaeological data for the terminal Archaic period after A.D. 200, a system of regional interaction must have been supported and maintained. While population diffusion may have spread inhabitants to more stable environments such as river valleys and central areas of aggregation, a portion of the population would have maintained stability through family ties despite being transhumant during the warm-weather months within the Laguna Plata region. If cultural adaptations within the northern Chihuahuan Desert were organized around a high mobility land-use pattern, then interaction with neighboring groups would not only have been inevitable, but essential for survival.

- In support of this assumption, nonlocal ceramic types appearing in the region during the Formative phases included Mimbres Black-on-white, Alma Plain, Three Rivers Red-on-terracotta, Corona corrugated ware, Chupadero Black-on-white, and El Paso Polychrome (Lehmer 1948; Simmons et al. 1989). Considered intrusive, the presence of these ceramic types implies a wider range of social interaction starting to occur during the early Formative period and progressing into the late Formative period.

- The expected presence of intrusive artifacts at LA 5148 may serve as supporting evidence that intraregional communication, with assumed social interaction with other (related) groups in the region, would have resulted in shared resource information, organized plans for cold-weather settlement, and affirmed territorial boundaries during the warm-weather months. To test the hypothesis that trade and exchange, both on a micro- and macrolevel of interaction was a critical mechanism for survival in an early Formative cultural environment, provenience of material types must be a primary focus.

5.8.1.3 Data Analysis

The primary requirements for identifying a network of regional interaction during the early Formative period are contingent on establishing provenience data for raw materials. Quantitative provenience for nonlocal pottery types using characterization studies such as INAA and x-ray fluorescence spectrometry (XRF) can be used as a correlating analytic technique for establishing ceramic provenience. Comparative analysis with known ceramic data sets may provide additional information on temper provenience.

6.0 Background History

Peter C. Condon

Prior to conducting fieldwork at LA 5148, the current listing of work performed in the Laguna Plata Archaeological District were reviewed (Table 6.1). This process was undertaken in an effort to obtain all available and relevant data concerning the Laguna Plata site. The scope of documented archaeological work performed within and adjacent to the district indicated 11 projects were conducted in the Laguna Plata Archaeological District between 1971 and 2004. Of those 11 projects, 81.80 (n=9) percent were survey projects, with the LCAS (Runyan 1971) and the Mississippi Chemical Company's Caprock Pipeline project (Haskell 1977) the only projects that entailed subsurface testing. Of note is Laumbach et al.'s (1979) cultural resource inventory of the proposed Laguna Plata Archaeological District. While this project did not include testing, the survey data proved invaluable towards understanding the dynamics of the site and immediate cultural landscapes. In particular, Laumbach et al. (1979) provided site information with regard to the supplemental 25-acre survey required under the Scope of Work for this project. As such, Runyan (1971), Haskell (1977), and Laumbach et al. (1979) were directly relevant to the current project. These three projects are summarized below.

Table 6.1 Summary of previous investigations in the Laguna Plata project area

Year	Project Undertaking	Sites Documented	Consultant	Reference
1971	Excavation	LA 5148	Lea County Archaeological Society	Runyan 1971, Runyan 1972
1976	Survey and Limited Excavation	ENM10017, ENM10018, ENM10020, ENM10021, ENM10022, ENM10024, ENM10026, ENM10028, ENM10030, ENM10031, and ENM10032	Agency for conservation Archaeology-Eastern New Mexico University (Mississippi Chemical Company's Caprock Water Pipeline)	Haskell 1977
1978	Survey		Agency for conservation Archaeology-Eastern New Mexico University	Schermer 1978
1979	Survey	NMSU 553, NMSU 554, NMSU 555, NMSU 566, NMSU 567, NMSU 568, NMSU 559, NMSU 560, NMSU 561, NMSU 562, NMSU 563, NMSU 564, NMSU 565, NMSU 569, NMSU 570-578	Cultural Resource Management Division of Sociology and Anthropology, New Mexico State University	Laumbach et al. 1979
1982	Survey	No sites	Agency for conservation Archaeology-Eastern New Mexico University	Kyte 1982a, 1982b
1982	Survey	n/a	Cultural Resource Management Division of Sociology and Anthropology, New Mexico State University (Teledyne Exploration Company)	Hilley 1982
1982	Survey	NMAS 5636 and NMAS 5637	New Mexico Archaeological Services (Tenneco Oil Company's Saltwater Pipeline)	Haskell 1982

Year	Project Undertaking	Sites Documented	Consultant	Reference
1985	Survey	n/a	Cultural Resource Management Division of Sociology and Anthropology, New Mexico State University (Anadarko Production Company)	Stuart 1985
1985	Survey	n/a	New Mexico Archaeological Services (Anadarko Production Company)	Haskell 1985
1987	Survey	NMAS 5839, NMAS 5840, NMAS 5844, NMAS 5845, NMAS 5846, NMAS 5847, and NMAS 5848	New Mexico Archaeological Services (Petro-Thermo Corporation's Plata Waste Water Disposal Project)	Haskell 1987
2004	Survey	LA 22112, LA 22115,LA 22116, LA 22121, and LA 22122	TRC Environmental, El Paso, Texas	Sale 2004

6.1 Lea County Archaeological Society Excavations (Runyan 1971)

In 1971, the LCAS under John Runyan conducted a series of excavations at LA 5148 (LCAS site No. C-10-C). These excavations focused on a small knoll on the western margin of the Laguna Plata playa. The field session was carried out between September 15, 1970 and January 31, 1971, under Antiquities Permit 70-NM-058 (Runyan 1971:3). Members of the LCAS excavated 45 5-ft x 5-ft units along a north/south oriented grid that covered most of the knoll (Figure 6.1). Excavation units were established in the north, central, and southern portions of the site. The southern portions of the site focused on areas of dense artifact concentrations and midden remnants, revealing three buried pit houses.

Initial excavations started with the site divided into four cardinal quadrants that facilitated the survey conducted prior to the subsurface testing. Subsequently, the entire site was divided into 5 x 5-ft Cartesian Coordinate grids. Each grid was assigned a coordinate based on where the unit fell within the north/south and east/west grid system. Excavation units were judgmentally placed within the grid resulting in a checkerboard pattern. Features, such as pit houses, were excavated in 4-inch arbitrary levels within the natural fill deposits. After the 5 x 5-ft unit was completed a 1.5 x 1.5-ft square was excavated in one corner to examine the underling stratigraphy. This system was done in units without features (Runyan 1971:5).

Three features, identified as pit houses, were exposed during excavation. Feature 1 was identified in the southeast portion of the site and consisted of a small remnant of a pit house (Runyan 1971:7). Approximately 21 postholes were exposed along the eastern margin of the structure (Runyan 1971:8, Figure 3). Feature 2, identified along the southern portion of the site, was a rectangular-shaped pit house outlined by 53 postholes. Feature 2 was 7.6 x 9.5-ft in size and contained a possible entryway in the southeast portion of the structure. Feature 3, an 8.3 x 10.5-ft structure in the southwest portion of the site, had 36 postholes outlining an irregular-shaped structure with squared sides. In addition to the buried structures, LCAS collected more than 6,000 artifacts (Runyan 1971, 1972).

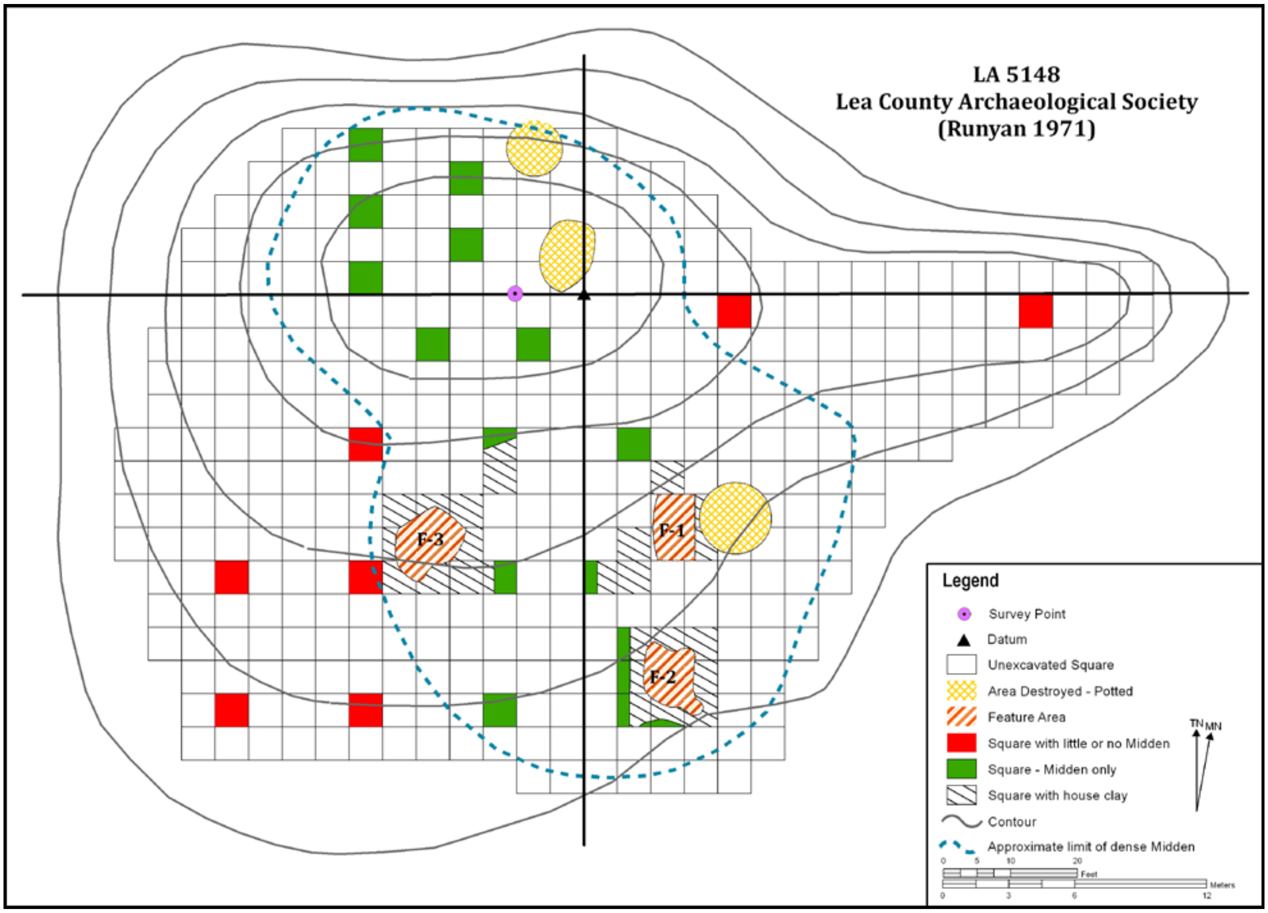

Figure 6.1 **Extent of Lea County Archaeological Society excavations at LA 5148 (Runyan 1971)**

6.2 Caprock Water System Archaeological Project (Haskell 1977)

During 1977, The ACA at ENMU contracted with the Mississippi Chemical Corporation to survey, collect, and carry out subsurface testing on archaeological sites positioned adjacent to and within the proposed right-of-way corridor of the Mississippi Caprock water line (Haskell 1977:1) (Figure 6.2). This project was conducted between November 14, 1975 and February of 1976. Initial survey and artifact recovery was conducted at nine sites (ENM10020, ENM10021, ENM10022, ENM10024, ENM10026, ENM10028, ENM10030, ENM10031, and ENM10032). Subsurface testing was conducted at ENM10026 and ENM10030. Sites ENM10017 and ENM10018 were tested in the winter of 1975 and 1976. ENM10017 incorporates LA 5148.

The Laguna Plata site as described in 1977 included a large, complex multi-component site that encompassed the 1971 LCAS site locus as well as areas to the north (More and Baker 1977:107). ENM10017 was subdivided into areas of interest, Localities 1 and 2. Locality 1are areas along the upper margins of the playa basin, while Locality 2 is within the basin proper and includes LA 5148. LA 5148 is designated Feature 1 with three artifact concentrations noted. These concentrations were identified as Areas A through C. Artifacts recovered outside these concentrations were collected as Area D. Although it is somewhat unclear, it appears that that the grid system used in 1977 at Locality 2-Feature 1 used the LCAS datum.

This page has been removed to protect confidential site location information.

Results of the Locality 2-Feature 1 investigation recovered 2,534 artifacts and included diagnostic projectile points and pottery sherds. The projectile points indicated an occupational range of A.D. 900–1500. The ceramic assemblage also suggested a similar period of site use, however, using more temporally sensitive types, intense site use appears to have occurred between A.D. 1200 and 1250, with less intense occupations after A.D. 1350. Two radiocarbon ages acquired during the excavation by ACA at ENM10017, but outside the current site boundary, provided a noncalibrated age of 760±95 B.P. (338E/19S, Level A) and 915±65 B.P. (341E/11S, Level A) (Burns 1977:283). When calibrated using OxCal (Version 3.1), these samples yield a 2-sigma calibrated age range of A.D. 1030–1400 and A.D. 1010–1260, respectively.

Based on the level of effort carried out at LA 5148, a fair assessment of site use entails occupations from the early Archaic through late Archaic, with intensive use post A.D. 600. This is in keeping with the ceramic assemblage documented by LCAS and ACA, which not only suggests local manufacture of brownware variants, but the possibility of trade and exchange with populations outside the region. Haskell's (1977) interpretation that the Laguna Plata site may be a limited base camp that was seasonally occupied is in keeping with current models presented by Condon et al. (2008b). It is unclear how site use is related to seasonality, and specifically, how Formative period occupations correlate with seasonal plant harvesting and bison hunting.

One human burial, a probable female between 20–23 years of age, was excavated within a dune blowout about 410 m west-northwest of the ENMU Feature 1 excavation area (Figure 6.2) in Locality 1. The individual was tightly flexed lying on its right side and its left os innominata was burned and totally deteriorated and the left femur was burned and fragmented. The body was oriented north-south with no associated artifacts. The skeleton was nearly complete with the absence of the basal portion of the occipital, the hyoid, four cervical vertebrae (including the axis), two ribs, the right clavicle, seven hand phalanges, four carpals, the left os innominate, the left patella, 25 feet phalanges, one metatarsal, and two tarsals. The skull was small with no frontal or parietal bosses or occipital deformation. Four wormian bones were present with one parietal foramen on the left side. A circular hole about 4 mm wide near the apex could explain the cause of death. The mastoid processes were small. The teeth were worn with the third molars slightly worn. The central incisors were not shovel shaped but the lateral maxillary incisors had slight shoveling. There were no dental caries or abscesses and no pathologies were noted. The height of the individual, using Genoves (1967) equation (2.59 Fem $+ 49.742 \pm 3.816$) was 160.34 cm (Vierra 1977).

6.2.1 Collections From Early Excavations at Laguna Plata

TRC sought to learn more about previous excavations of the site and to locate collections from the earlier excavations, placing special emphasis on identifying and locating the human remains removed from the site during the excavations, as part of its archaeological research on the Laguna Plata site. Martha Graham (Ethnographic Project Manager, TRC-Albuquerque) conducted these investigations. As previously discussed in this report, the LCAS conducted excavations at the Laguna Plata Site in 1970–1971. Eastern New Mexico University's (ENMU) ACA excavated the site as part of the Caprock Water Project in 1977.

The results of Graham's investigations are briefly summarized here. Her unabridged report is in Appendix J. TRC did not locate any additional field notes or other documentation about the LCAS, nor did it succeed in locating any member of LCAS that participated in excavations at the Laguna Plata site. TRC reviewed the collections and associated documentation from ENMU's excavations, including human remains (excavated in 1977, see above), currently housed in the ENMU Curational Facility. TRC also identified and corresponded with several members of ENMU's 1977 excavations, none of whom had information to add to the documentation at ENMU.

TRC has concluded that further efforts to locate and interview former excavators about their participation in the Laguna Plata excavations probably would not yield additional information. TRC also determined that field notes and collections from ENMU's excavations are readily accessible and well organized. The human remains from ENMU's excavations are housed at the ENMU Curational Facility. All skeletal elements reported as excavated in 1977 are present. One discrepancy in the human remains' provenience appears to be a transcription error. ENMU has a relatively small number of photographs, stored separately from the artifacts or fields notes, which were not available when Graham visited ENMU. John Montgomery, Anthropological Museum Director, ENMU, currently is investigating this matter to determine whether additional photographs exist. Following is a brief description of the results of TRC's efforts and conclusions.

Graham's findings specific to the BLM's goals were—

Did not succeed in locating anyone from the original LCAS 1970–1971 excavations at the Laguna Plata site. It is unlikely that additional efforts in this regard would be worthwhile.

Contacted several individuals who had participated in the Caprock project and ENMU's 1977 excavations at the Laguna Plata site. None of these offered insights or additional detail into the site or the fieldwork.

The collections from the ACA's Caprock Project are well organized and curated at the ENMU Curation Facility. The collections database appears to be accurate.

The human remains that ENMU excavated are in the ENMU Collection Facility. The difference in provenience for one element is likely a transcription error.

Although several artifacts are identified as having some association with the human remains, their specific association is not clear. Bradley Vierra (archaeologist, Caprock project) reported that there were no funerary objects associated with the human remains.

No photographs from ENMU's collections were reviewed during this project. A small number of photographs have been located, and Dr. Montgomery is attempting to ascertain the existence and location of others.

6.3 A Cultural Resource Inventory of the Proposed Laguna Plata Archaeological District (Laumbach et al. 1979)

A cultural resource inventory of the proposed Laguna Plata Archaeological District is a report prepared by the Cultural Resource Management Division of Sociology and Anthropology, New Mexico State University, Las Cruces for the BLM, Roswell District. Personnel from the cultural resource division of the Department of Sociology and Anthropology at NMSU conducted a Class III inventory near the Laguna Plata site. The primary goal of the project was to determine the boundaries of the archaeological district. The Class III survey was conducted between July 16 and August 3, 1979. Twenty-six sites and 75 isolated artifact occurrences were recorded resulting in expanding the district boundaries to the east and southeast of the playa.

The Laguna Plata site, as documented by NMSU, measured 1,092,650m^2 and was subdivided into areas designated A through C. Each of these areas were bounded by cultural and topographic breaks. Area C corresponds to the LCAS excavation area (1971). Overall, the site consisted of scatters of fire-cracked rock and singular carbon stains. The artifact assemblage consisted of lithic debitage, cores, hammerstones, ground stone artifacts, and shell ornaments. The projectile points recovered correlated with Leslie's (1978) Type 3-C, which dates between A.D. 1000 and 1200, Type 6-B and Type 6-C, which date between A.D. 850 and 1000. The ceramic assemblage had both local and nonlocal pottery styles. The temporal affiliation provided by the ceramics ranged from A.D. 1150 to 1400. Inventory data provided by the project helped quantify the boundaries of the archaeological district and resulted in the expansion of LA 5148 through the combining of numerous sites under one Laboratory of Anthropology number (Laumbach et al. 1979).

7.0 Field Methods

Peter C. Condon and Benjamin G. Bury

The general work plan for the testing project is outlined below. The section discusses mapping, surface collections, manual excavations, geomorphology, and use of heavy machinery as support for the testing.

7.1 Locating Previous Excavations

One of the primary goals of this project was to discern the location of the LCAS (1970–1971) and the ACA (1975–1976) excavations. TRC's proposed method for locating these previous excavations consisted of a multi-phase approach beginning by locating artifact collections, photographs of excavations, and field and laboratory documentation generated during the LCAS and ENMU-ACA projects.

Initial work consisted of examining aerial photographs to discern human-made site disturbances, particularly those that have a geometric pattern (e.g., squares, rectangles, lines [trenches]). These were ground-truthed during the fieldwork phase to verify if they represent previous excavations. While searching for collections, photos, and documentation of the previous investigations, TRC attempted to contact and interview representatives of museums, repositories, and organizations involved with excavations at the Laguna Plata site to ascertain the locations and learn the nature of the materials excavated. Sources included the BLM Carlsbad Field Office, ENMU, the University of Michigan, the LCAS, ENMU, New Mexico Junior College, and members of Troop 198 of the Boy Scouts of America involved in the previous excavations.

7.2 Mapping and Surface Collection

Earlier NRHP evaluations at LA 5148 completed varying levels of effort that included surface inventory and delineates the site boundary to detailed site documentation, artifact analysis, topographic mapping, and test excavations (Runyan 1971; Haskell 1977; Laumbach et al. 1979). The initial site inspections prior to this testing project indicated cultural materials were differentially spread across the site since previous field sessions. Adverse impacts to the site ranged from light to heavy, with the most notable resulting from arroyo incising, aeolian deflation, and local collecting. Oil and gas development does not appear to be a factor at LA 5148.

Previous site recordings at LA 5148 were done in the fall of 1970 and winter of 1971 by the LCAS (Runyan 1971) and in 1976 and 1977 by ENMU-ACA (Haskell 1977). During the LCAS project, the site recording was limited to a 150 ft (47.24 m) x 100 ft (30.48 m) Cartesian coordinate grid that encompassed a 0.35-acre (1,440 m2) area identified as C-10-C (Runyan 1971:7). Although features, middens, excavations units, and elevation contours were mapped, no surface artifacts were provenienced. All artifacts recovered during the LCAS fieldwork were collected during excavation.

In contrast, ENMU-ACA conducted large-scale mapping and surface collection, but limited test excavations (Haskell 1977). Surface mapping and artifact collection was restricted to an 840 m x 60 m northeast/southwest oriented pipeline corridor and five smaller transects extending east into the playa basin. The pipeline corridor was 280 m west of the basin rim along an existing northeast/southwest oriented two-track road. Four transects extended east from this corridor, breaching the basin rim and extending into the basin, the longest continuing past LA 5148 480 m from the corridor right-of-way (Haskell 1977:7). During the initial pipeline corridor survey, ENMU-ACA employed a 100 percent collection strategy and a 20 percent collection strategy within the five external transects. According to Haskell (1977), these ancillary transects bypassed the LCAS excavation areas to the north and to the south of the C-1-C location. However, ten 1 x 1-m test units were excavated along the eastern portion of the LCAS site area and immediately east of the C-10-C site boundary (Haskell 1977; Nielson 1976, Caprock Pipeline Project field notes, archived at ENMU).

Initial work during this testing project focused on reestablishing the Cartesian coordinate grid and datum as defined by Runyan (1971). Reconstruction of the site grids allowed TRC to coordinate provenience points and identify Features 2 and 3 as defined from previous work. Both GPS and EDM instruments were used to establish and document the original provenience controls. Using known points from previous investigations, the LCAS datum and backsight subdatum were identified, feature locations were tentatively verified, and the original grid systems were reestablished. Once previous datum locations and the grid system were determined, the overall accuracy of the LCAS map was checked for modifications or updates. Once the LCAS excavation area was verified, TRC marked the overall site boundary as defined by the BLM-Carlsbad Field Office with surveyor's flagging tape, a second datum was established, and the UTM coordinates were collected for precise mapping. The UTM coordinates of the TRC site datum were recorded by using a Trimble Geo XT GPS. Site grids were oriented to true north. All grid coordinates were tied into the site datum's corrected UTM coordinates.

After the boundary for LA 5148 was delineated, a pedestrian survey was conducted across the site. The survey parcels were divided by natural breaks in the topography, usually determined by arroyo cuts, resulting in five arbitrary survey sections (Laumbach et al. 1979). Singular artifacts, artifact concentrations, and features were marked with pin flags and were point provenienced using the EDM or the Trimble GeoXT GPS. Due to the site's artifact density, a random 10 percent sampling strategy recording one of every ten artifacts was employed. Artifacts selected were documented and analyzed in the field using a standardized classification system that included, at minimum, artifact and material type. Diagnostic artifacts, including projectile points, decorated pottery, rim sherds, exotic, and unusual artifacts were collected. When encountered, obsidian was also collected. Collected material was placed in resealable polyethylene bags with an acid-free identification tag. The tags contained the project number, site number, provenience number, unit or block number, depth below datum, feature number when applicable, north and east coordinates, contents, excavator(s), date, and the assigned collection number.

In addition to the site survey and update, 25 acres outside of site boundary were surveyed as part of this task order. Five 5-acre blocks were surveyed using linear transects spaced 10 m apart. Cultural materials were recorded using ArcPad GPS software with supplemental recording using HP iPAQ hx2000 series Pocket PC. The Trimble GeoXT GPS units provided an on-screen aerial view of the survey area and a shape file containing the UTM coordinates for 10 m transect. All artifacts and features encountered were recorded with point provenience and mapped. Diagnostic artifacts were collected.

After the initial survey and site documentation was completed the use of remote sensing techniques were used to determine the locations of previous investigations within the LCAS excavation area. The remote sensing survey instruments included a Geophysical Survey Systems Inc. EMP-400 ground conductivity meter, and a Sensors & Software 250 MHz ground penetrating radar (GPR) operated by Mr. David Hyndman of Sunbelt Geophysics, Socorro, New Mexico. The results of the geophysical survey are presented in Section 8.0.

7.3 Manual and Mechanical Excavations

Both manual and mechanical excavations were conducted at LA 5148. Excavation techniques followed the basic recovery methods of the Bear Grass Draw project conducted by TRC Environmental (Condon et al. 2008a). TRC proposed excavating 30 1 x 1-m units to reveal and investigate Features 2 and 3 of the LCAS excavations (Runyan 1971).Deviations from this plan were made in conjunction with George MacDonell, Lead Archaeologist, BLM-CFO on April 26, 2010.

During the manual excavations, horizontal control was limited to 1 m x 1-m grid units. Stratum I was excavated as a natural level, usually associated with overlying modern aeolian sand deposits. Subsequent soil horizons were designated consecutive numerical values (Stratum II-Level 1, Stratum III-Level 1, etc.) which were later correlated with the stratigraphic series for the site The level of effort to expose Features 2 and 3 consisted of a Stratum I-aeolian sands, Stratum II-LCAS backfill, and Stratum III-reddish/orange alluvium. Feature 6, a pit feature identified south of the LCAS project area was also excavated. The pit feature was located on the present ground surface and it intruded into the underlying Ab and B soil horizons. All excavated sediments were processed through 1/8-inch hardware screens.

Once exposed, Features 2 and 3 were documented; data regarding dimensions, construction details, possible chronological age, and function were collected. Samples included carbon-stained sediment and wood charcoal recovered in the form of charred posts. Samples were submitted for AMS radiocarbon dating. Wood charcoal from Feature 6 was also collected and submitted for AMS dating. As no feature fill was present in Features 2 and 3, no sediment samples were processed. Soil samples for Feature 6 were separated by flotation, and light fractions were submitted for macrobotanical analysis. Because of the poor preservation documented in highly deflated, arid environments, pollen samples were selectively submitted for analysis (Dering et al. 2001; Quigg et al. 2001).

After being photographed and drawn in plan view, features were bisected to obtain a cross-section profile. Profiles were drawn and photographed. All sediments were processed through 1/8-inch hardware mesh or collected for additional studies. A final plan view was drawn and a photograph taken after a feature was excavated. The center point of the feature was calculated in reference to the grid system, and all horizontal provenience information was referred to that point.

Mechanical investigations consisted of 1-m wide backhoe trenches placed in areas of the site that facilitated the greatest information on stratigraphy. The goals of the mechanical investigations were to determine the geomorphic strata and to locate intact subsurface cultural deposits. Each trench profile was drawn and analyzed by TRC's geomorphologist Dr. Charles Frederick and are presented in Section 11.0. Cultural deposits located during the backhoe trenching were tied into the site's grid system using the total station.

8.0 Geophysical Analysis

David A. Hyndman

8.1 Introduction

A geophysical assessment was conducted within selected portions of LA 5148. The objective of the assessment was to discern the location and extent of previous excavations. Geophysical surveys were conducted using a magnetometer, a ground conductivity meter, and ground penetrating radar. The fieldwork for the geophysical assessment was conducted on April 22 and 23, 2010. Labor, instrumentation, and technical expertise were provided by Sunbelt Geophysics of Socorro, New Mexico. Guidance, coordination, and survey support were provided by TRC Environmental Corporation.

A primary and two secondary areas were designated for geophysical surveying by the TRC supervisor. The primary area was thought to be the locus of the LCAS excavations conducted in 1970-1971 and was designated LCAS Excavation Area 1. The two secondary loci were further to the south and were designated Area 2, Subareas A and B.

8.2 Methods

A spatial control grid was placed at each of the three areas using a transit and tape. These grids established parallel data acquisition lines oriented north to south and separated by 1 m. The grid at the LCAS Excavation Area 1 extended 25 m north-south and 20 m east-west and was positioned with respect to a vertical steel pipe thought to be a spatial datum marker from the previous excavation. The Area 2, Subarea A grid extended 10 m north-south and 14 m east-west. The Area 2, Subarea B grid extended 20 m north-south and 6 m east-west. The geo-referenced locations for these grids were determined by TRC.

The LCAS Area 1 was surveyed using a Geometrics G-858 cesium vapor magnetometer, a Geophysical Survey Systems Inc. EMP-400 ground conductivity profiler, and a Sensors & Software Noggin 250 MHz ground penetrating radar (GPR). Magnetometer data were acquired approximately every 20 cm along each transect. EMP-400 data were acquired approximately every 35 cm. Individual GPR records were acquired approximately every 5 cm along each transect.

Subareas A and B of Area 2 were surveyed using only the GPR. Data from the magnetometer, EMP-400 and GPR were recorded by data loggers intrinsic to each instrument. These data were transferred to a computer for processing, analysis and mapping. The MagMapper (Geometrics Inc.) and Ekko-View (Sensors & Software Ltd.) programs were used for data processing and the Oasis montaj (Geosoft Ltd.) program was used for analysis and image preparation.

8.3 Results

8.3.1 LCAS Area 1-Magnetic Survey Results

Almost all small-scale and near-surface anomalies in the strength of the earth's magnetic field are generated either by the presence of iron/steel objects or by lateral variations in the concentration of the mineral magnetite. Lateral variations in magnetite can be due to stream deposits ("black sand"), stones of igneous origin, fire alteration of hematite, and other natural and cultural processes. Hematite, which is not significantly magnetic, can be reduced to magnetite by heating in fire pits or hearths. Hematite is the iron oxide giving the red or rust color to certain rock beds and to soil derived from these red beds. Such red beds are observed in the vicinity of Laguna Plata and the soil has a red tint.

An image of the magnetometer data is in Figure 8.1, which depicts the strength of the total magnetic field in nanoTesla (nT). This image is dominated by the magnetic signature of the vertical metal pipe located at 10E, 25N. This pipe was assumed to be a datum marker from the LCAS excavations. Some magnetic readings in the immediate vicinity of this pipe were edited from the dataset to diminish the dynamic range of the image. The magnetic field strength displays a gentle trend of decreasing magnetic field strength from west to east, presumably due to subsurface soil composition and terrain.

Several magnetic features are discernible despite the influence of the metal pipe and the general magnetic trend. Two magnetic dipoles (relative magnetic high with intimately associated magnetic low) are near the western edge of the survey (1E, 6N and 3E, 11N). Such dipoles are very suggestive of metal objects and these features may be generated by iron/steel nails or spikes used during the previous excavation activities.

A relatively strong magnetic high is at 12E, 10N. This anomaly may also be generated by iron/steel object(s), but the lack of a dipole (no corresponding magnetic low) opens the possibility of a fired feature such as a fire pit or hearth. The native soil has a rust tint indicating that at least some hematite is available for fire alteration. Three small magnetic highs are observed near the eastern edge of the survey and are labeled "?". These may be small iron/steel objects, igneous stone, or possibly fired features.

8.3.2 LCAS Area 1-Ground Conductivity Survey

Small-scale anomalies in the electrical conductivity of the ground are primarily generated by lateral changes in soil moisture and secondarily by lateral variation in soil minerals. Elevated moisture, salts, and clay minerals increase the ground conductivity. Cultural activities generally increase the ground conductivity. Digging disrupts in-situ soil layering, which can often be mapped, and provides areas of preferential rainwater infiltration and excess moisture. Hard-packed areas can impede vertical movement and evaporation of soil moisture, generating elevated conductivity. The survey site is immediately adjacent to a playa and elevated concentrations of salts and other evaporites are assumed to be in the soil.

An image of the EMP – 400 data is shown in Figure 8.2, which depicts the apparent ground conductivity in units of milliSiemen/meter (mS/m). This image displays a general trend of increasing conductivity from the northwest to southeast, presumably reflecting near-surface drainage from relatively higher ground and possibly an increasing salt concentration.

An area of very high conductivity (red) is observed along the southern edge of the survey from 0E to approximately 14E. This is suggestive of disturbed soil allowing preferential infiltration of rainwater. There is no obvious surface expression of disturbed soil or a "wet spot" at this location. The ground surface is sloped and relatively smooth. A local low area with visual indications of puddling is located approximately 8 m to the south (down slope).

A second relatively strong conductivity anomaly is at approximately 14E, 6N. This feature has dimensions of approximately 2 m x 2 m, and is suggestive of an excavation. A mild conductivity anomaly is found at approximately 6E, 17N, again suggestive of a shallow excavation.

8.3.3 LCAS Area 1-Ground Penetrating Radar

Local conditions were not good for high-resolution GPR surveying. The ground conductivity is high, indicating rapid dispersion of GPR energy at shallow depth. Effective penetration was only on the order of 1 m with relatively low signal to noise. The low signal level required that high gain be applied to the data, introducing processing artifacts. Additionally, the ground surface was rough due to numerous clumps of grass. Traversing the GPR antenna over these clumps resulted in variable antenna coupling to the ground. This variable coupling limited near-surface interpretation to only the strongest signals and introduced noise to reflectors at depth. Despite these limitations, the GPR survey provided several features suggestive of previous excavations.

Figure 8.3 provides south to north profiles along Lines 1E and 2E. A band of noise generated by the high gain applied to the data is annotated on the top profile. A typical example of noise generated by surface roughness is annotated on the bottom profile. A soil layer at a depth of approximately 70 cm is annotated on the bottom profile; this layer could be found extending for several meters on most of the GPR profiles. Please note the abrupt distortion of this soil layer immediately below and generated by the surface noise. Features suggestive of previous excavations are annotated on Figure 8.3. Feature A is a small reflection at a depth of approximately 30 cm. Individually, such a small feature would be ignored, but a very similar feature is observed at this approximate position on every south to north profile from 0E to 15E, indicating a linear trend. Feature B suggests an excavation 2 to 3 m wide to a depth of approximately 1 meter.

Figure 8.4 provides an alternate image of Feature A, that was annotated on the previous figure. Feature A is seen as a shallow, long and variable reflection from approximately 30 cm depth, extending from 0E to 15E with a slight southern drift.

The top two profiles shown in Figure 8.5 provide Feature C, an anomalous reflection from a depth of about 50 cm. This has areal dimensions on the order of 2 m and deeper structure may be present. The bottom profile in Figure 8.5 (Line 8E) shows a conical feature penetrating to a depth of 1 m that is designated Feature D.

An anomalous soil layer is designated Feature E in Figure 8.6. This subsurface layer rises toward the ground surface in the northeast corner of the surveyed area, incongruent with the generally flat soil/rock layers exposed nearby. The feature is at least 2.5 m wide (east-west) and 6 m long (north-south) and may continue to the north and east beyond the survey area. The positions and approximate extents of the magnetic, ground conductivity and GPR features are shown in Figure 8.7.

8.4 LA 5148 Area 2

Area 2 was described as being very disturbed by “potting” even to include mechanical excavations. The GPR performance within Area 2 was somewhat less than in Area 1, with an effective penetration to approximately 50 cm. Several near-surface features suggestive of excavations were identified in both Subareas A and B. Examples GPR profiles are shown in Figure 8.8. Interpretations of disturbed ground are shown in Figure 8.9 (Subarea A) and Figure 8.10 (Subarea B). Subarea A is found to be very disturbed, Subarea B somewhat less.

8.5 Summary

The geophysical assessment within portions of LA 5148 was successful in identifying several subsurface features suggestive of previous excavations. Features within the LCAS Area 1, primarily clustered in the middle and south of the surveyed area, include:

- Six magnetic features were found, possibly from iron/steel objects or positioning spikes left by the LCAS excavations (see Figures 8.1 and 8.7).
- Three ground conductivity features were mapped and interpreted to be from disturbed ground permitting anomalous rainwater infiltration (see Figures 8.2 and 8.7).
- Five GPR features are interpreted with all but one in the southwest portion of the surveyed area (see Figures 8.3 to 8.7).
- A long and thin GPR feature (Feature A) can be spatially correlated to a linear trend in ground conductivity located near the bottom (south) of the surveyed area. It is possible that a shallow trench generated the GPR feature and this soil disruption allows excess rainwater infiltration to generate the elevated ground conductivity anomaly.

The GPR surveys within Area 2 found considerable disturbed ground as shown Figure 8.9 for Subarea A and Figure 8.10 for Subarea B.

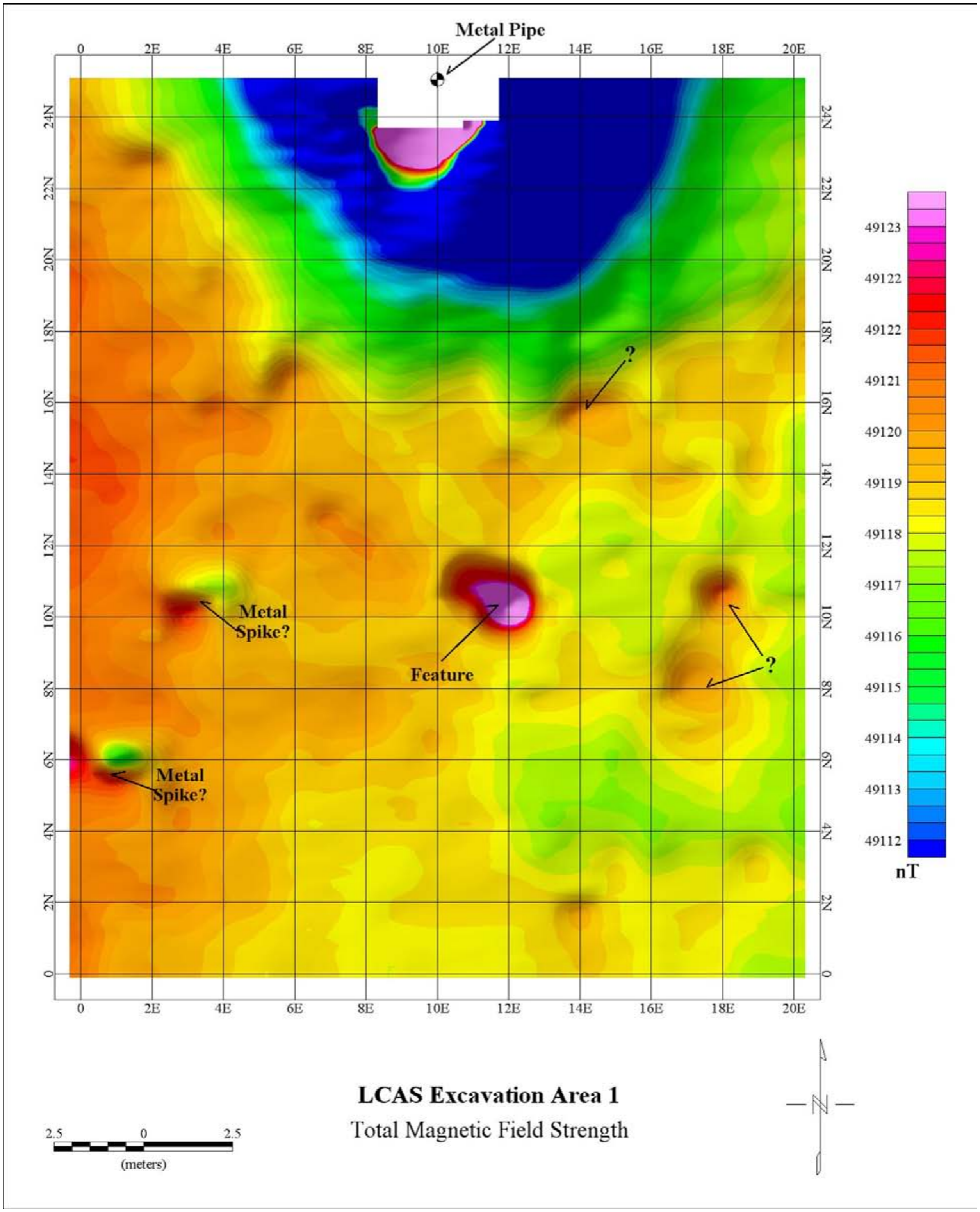

Figure 8.1 Total magnetic field strength, LCAS Area 1

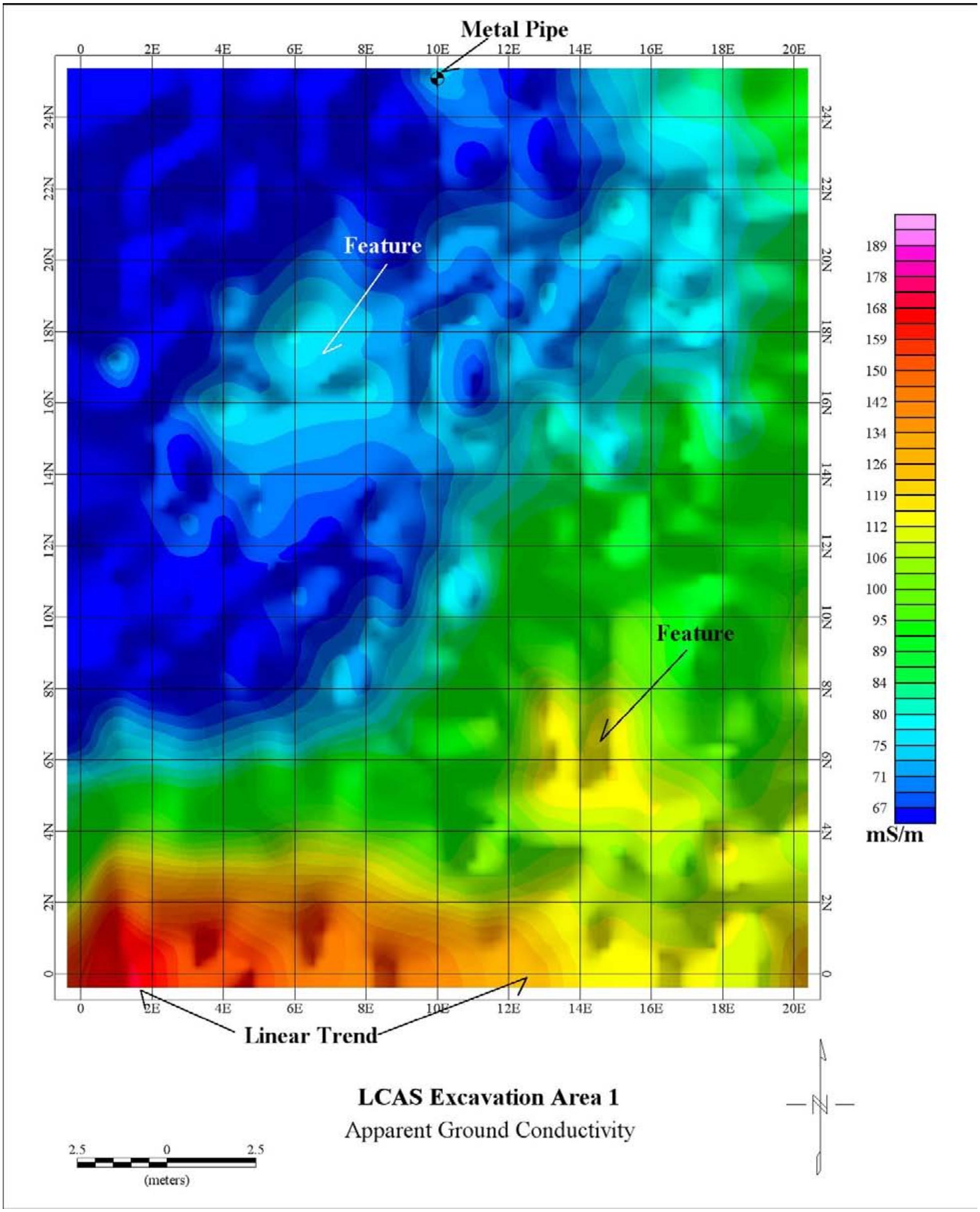

Figure 8.2 Apparent ground conductivity, LCAS Area 1

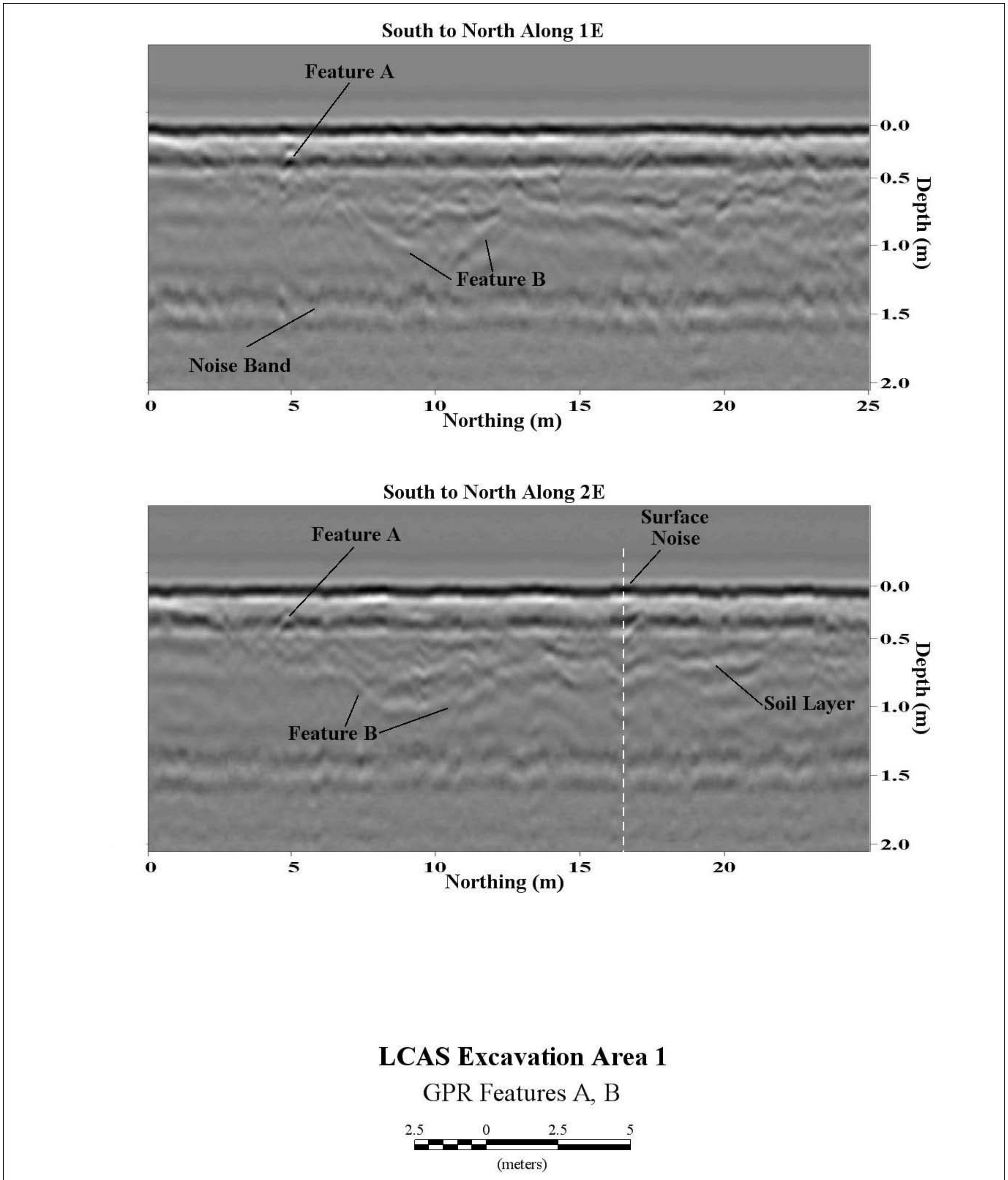

Figure 8.3 GPR Features A and B, LCAS Area 1

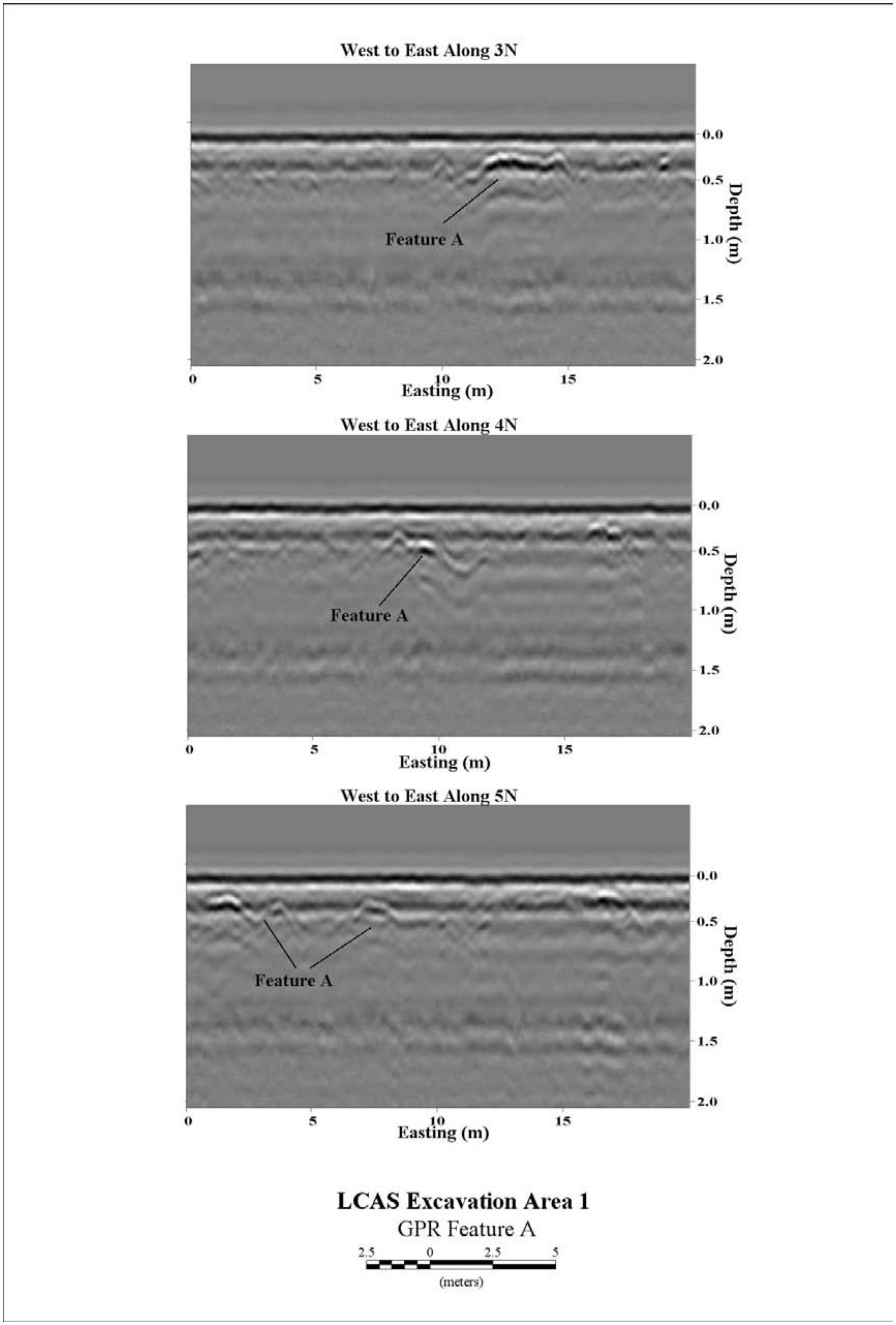

Figure 8.4 GPR Feature A, LCAS Area 1

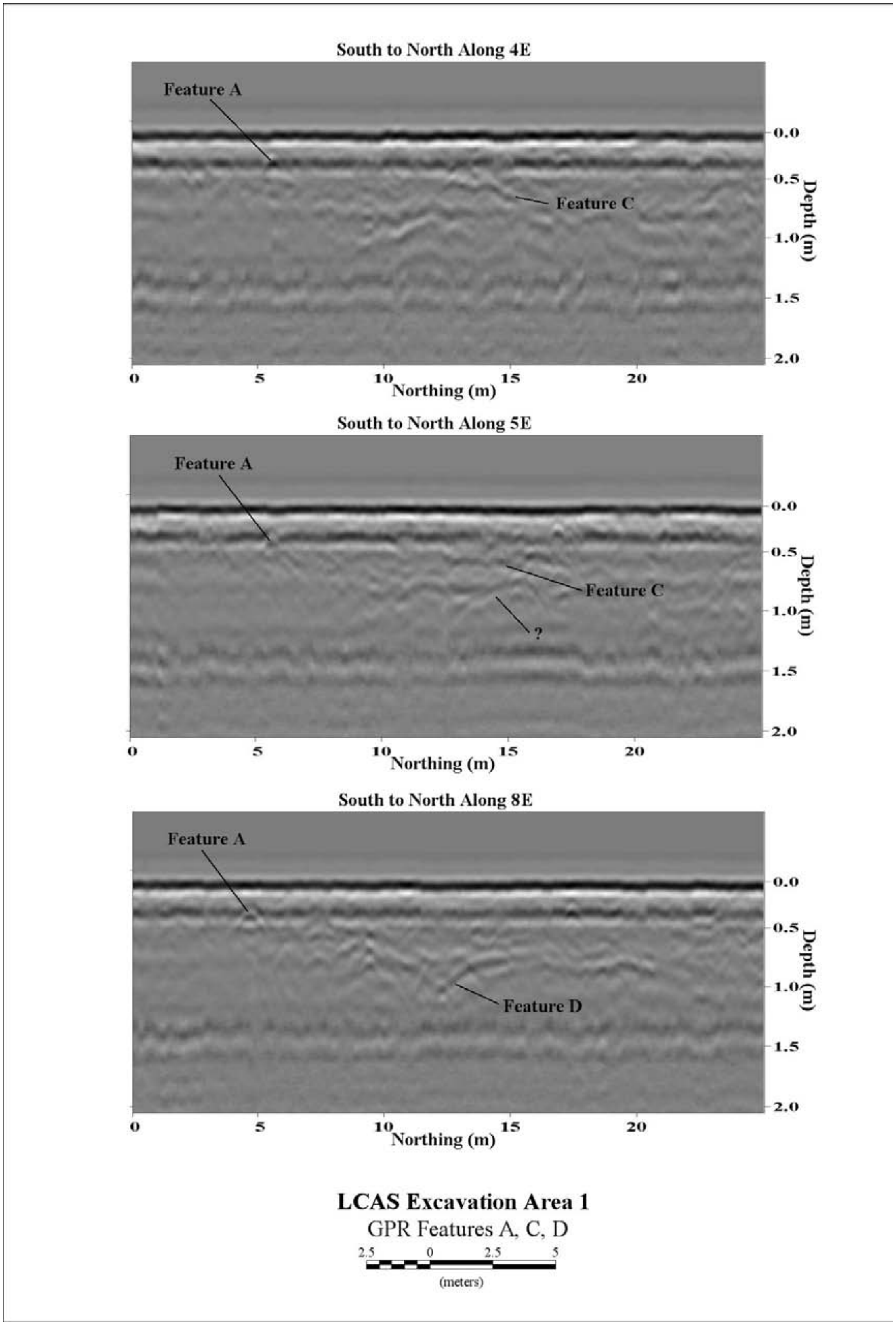

Figure 8.5 GPR Features A, C, and D, LCAS Area 1

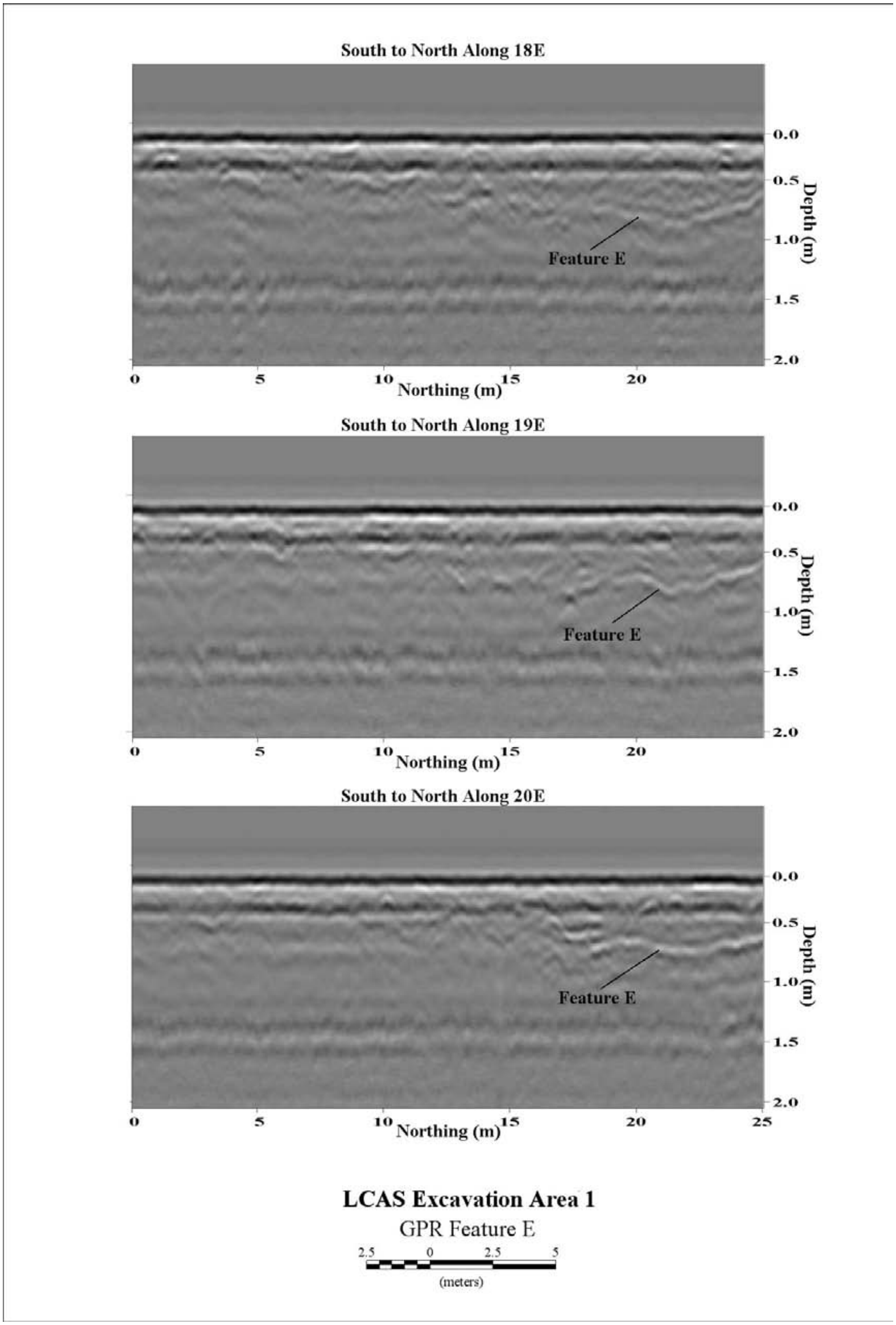

Figure 8.6 GPR Feature E, LCAS Area 1

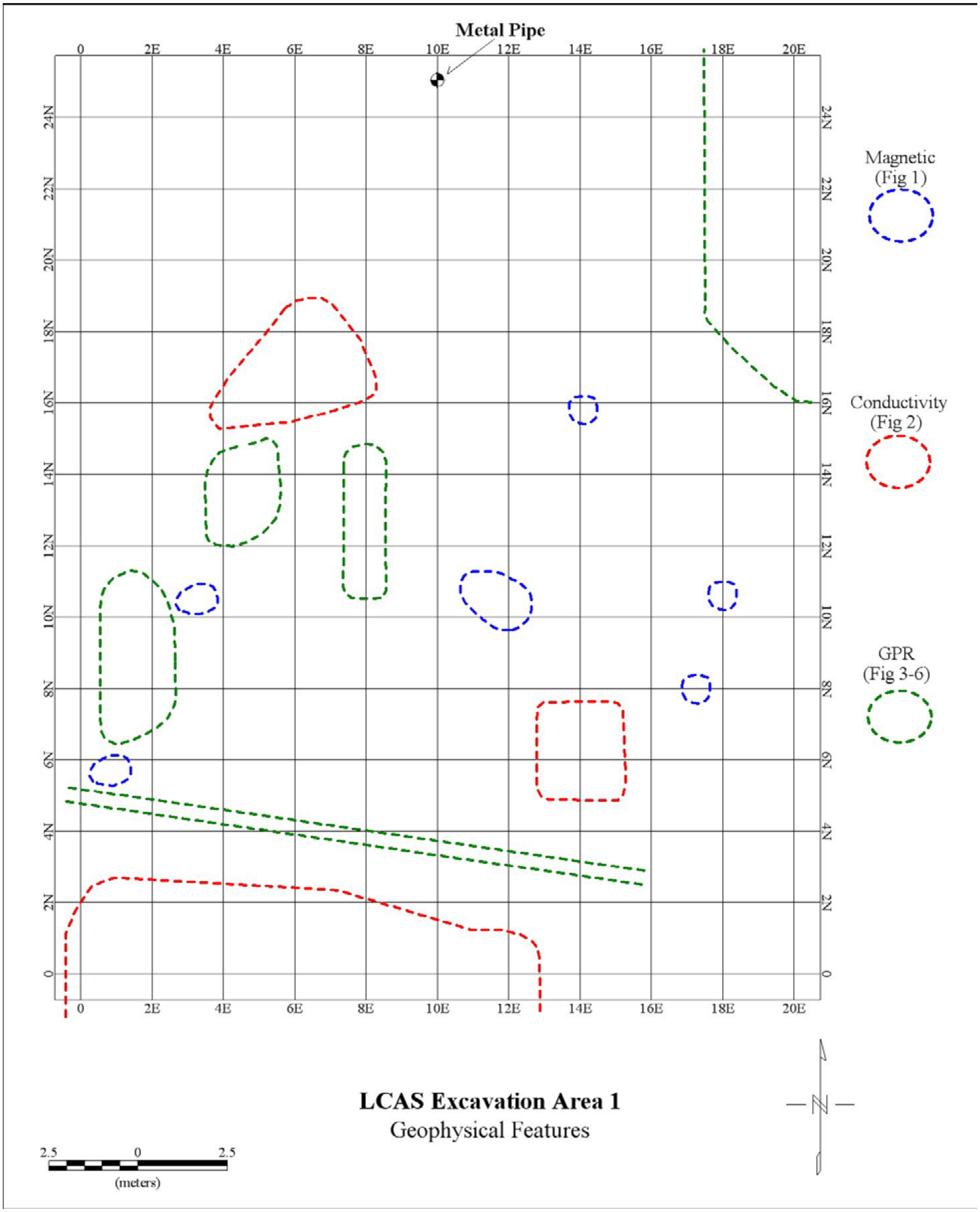

Figure 8.7 Geophysical features, LCAS Area 1

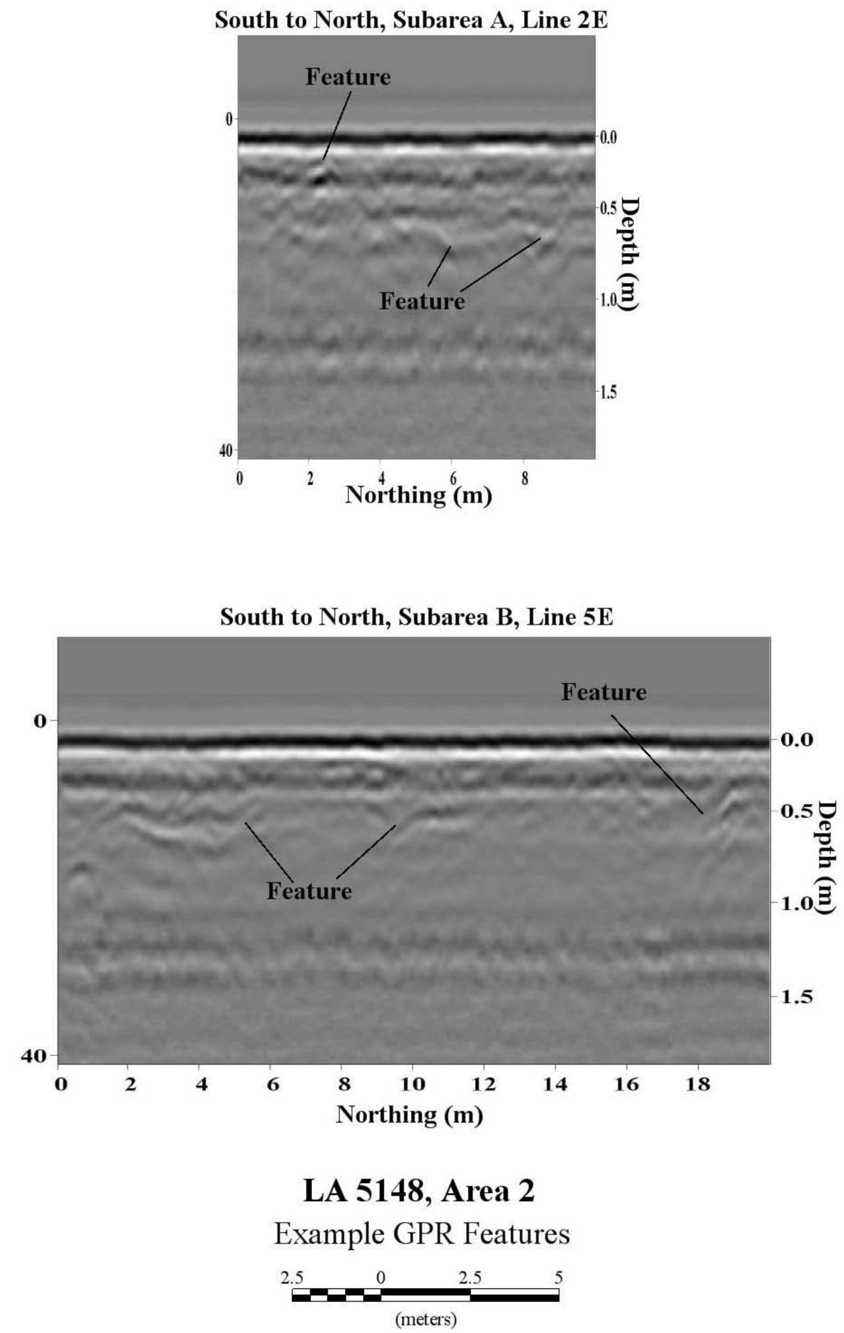

Figure 8.8 Example GPR features, LA 5148, Area 2

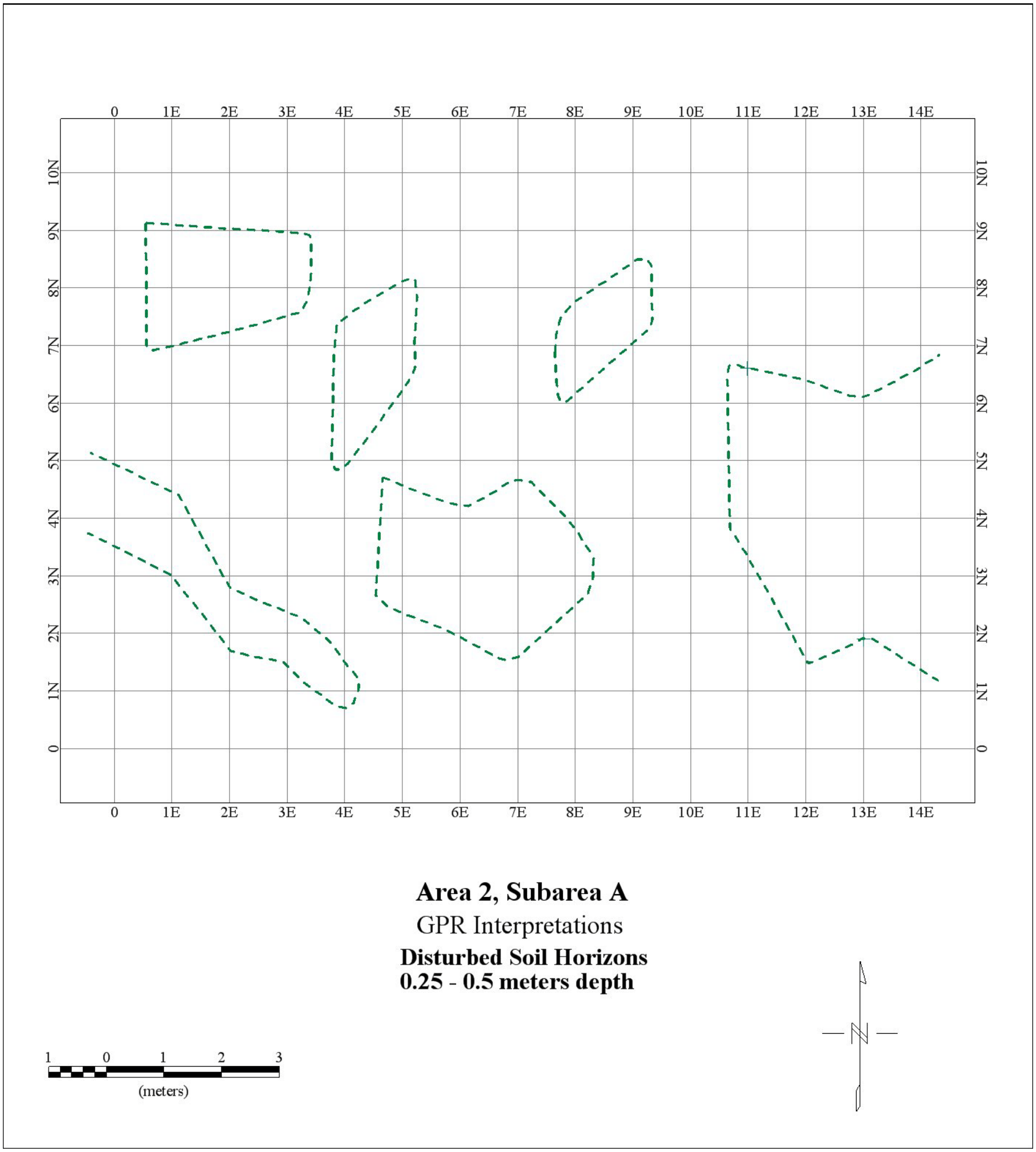

Figure 8.9 GPR interpretations, Area 2, Subarea A

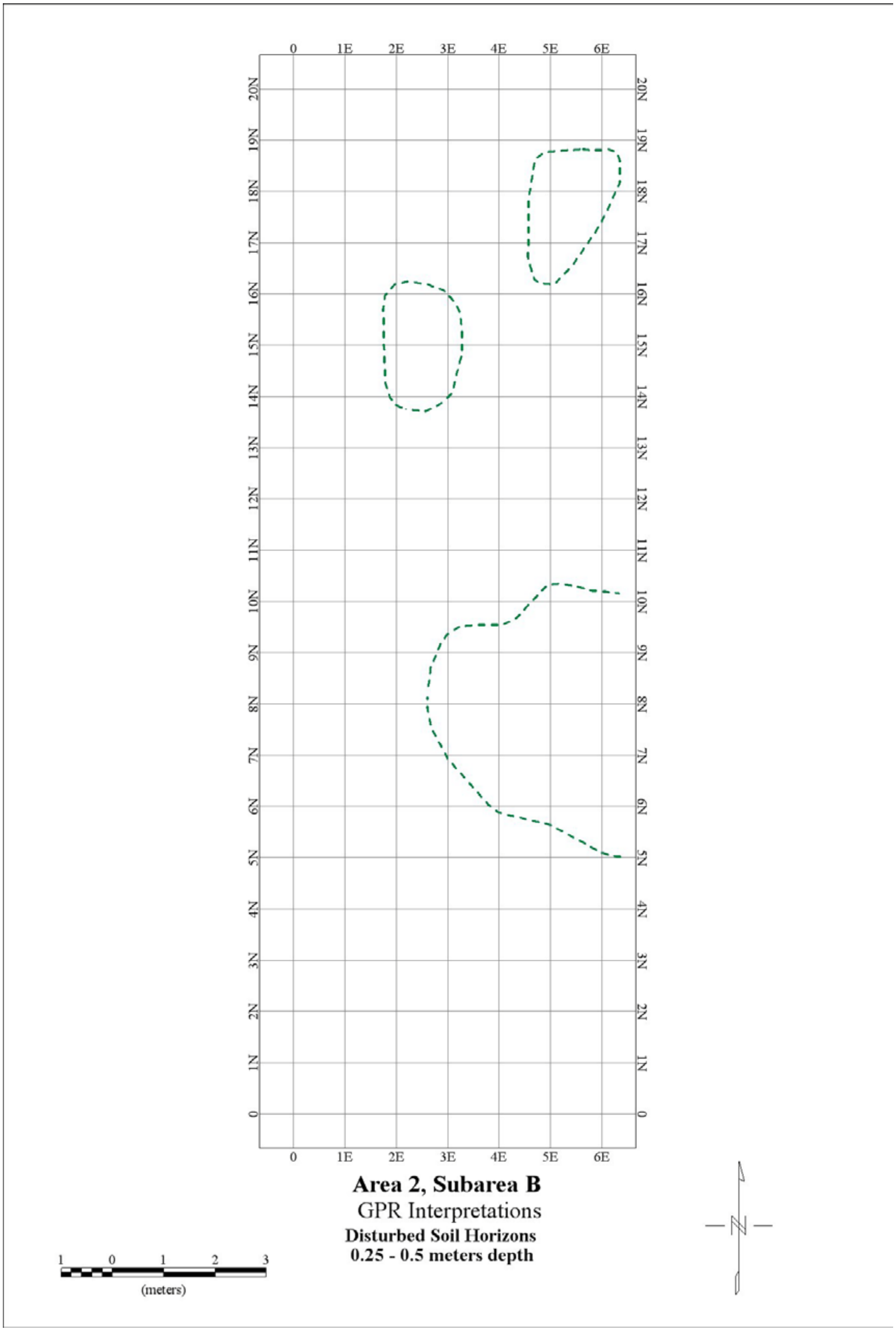

Figure 8.10 GPR interpretations, Area 2, Subarea B

9.0 Archaeological Testing Results

Peter C. Condon

During the testing phase, TRC completed four principal tasks: 1) documentation, mapping, and select the collection of diagnostic artifacts; 2) evaluating features for contextual integrity; 3) select features for excavation; and 4) subsurface trenching and geomorphological study.

Excavation and recording methods followed the project research design (Condon et al. 2008a). Prior to subsurface testing, all features were documented, and tested for contextual integrity. Based on the level of effort chosen for a particular site, manual excavations were done. If manual excavations were carried out, excavated sediments from unit levels were screened through 1/8-inch hardware mesh. Radiocarbon, macrobotanical, FTIR organic residue, starch grain analysis, XRF, and INAA samples were selectively collected from appropriate contexts (Table 9.1). Plan views and profiles were drawn for all excavated features. The site and excavations were thoroughly photographed to ensure a detailed record of the investigations. Diagnostic artifacts, including projectile points, rim sherds, decorated sherds, obsidian, and ornaments were collected.

Table 9.1 Samples submitted for analysis

Analysis	Sample	Provenience
Radiocarbon (AMS)	Wood Charcoal	Feature 2 (P# 21)
	Wood Charcoal	Feature 3 (P# 16)
	Wood Charcoal	Feature 3 (P# 18)
	Wood Charcoal	Feature 6 (P# 49)
	Soil Sample	Trench 1 (100 cm bgs)
	Soil Sample	Trench 1 (238 cm bgs)
	Bison Bone	Trench 6
	Soil Sample	Trench 8
	Soil Sample	Trench 8
Macrofloral Analysis	Light Fraction	Feature 2 (P# 21)
	Light Fraction	Feature 3 (P# 18)
	Light Fraction	Feature 6 (P# 49.1)
	Light Fraction	Feature 6 (P# 49.2)
	Indeterminate Pod	LCAS Cat. # 369; 6S 3E-G
Starch Grain Analysis	Ground stone Fragment	Test Unit 2/Feature 3 (P# 6)
	Ground stone Fragment	Surface (P# 47)
	Ground stone Fragment	Surface (P# 50)
	Ceramic Sherd	LCAS Cat. # 221; 12S 2E-Z
	Ceramic Sherd	Surface (P# 229)
	Ceramic Sherd	LCAS Cat. #517; 6S #w-A
	Ceramic Sherd	LCAS Cat. #662; B2
FTIR Residue Analysis	Ground stone Fragment	Test Unit 2/Feature 3 (P# 6)
		Surface (P# 38)
		Surface (P# 42)
		Surface (P# 50)
		Surface (P# 52)
		Unit D-2- (P# 206)
		Unit D-2- (P# 580)

Analysis	Sample	Provenience
Pollen Analysis	Soil Sample	Trench 6/Zone 3 (2)
	Soil Sample	Trench 6/Zone 5 (1)
	Soil Sample	Trench 6/Zone 8 (3)
	Soil Sample	BT-1/133-142 cm (4)
	Soil Sample	BT-1/235-24- cm (5)
Diatom Analysis	Soil Sample	Salina Floor
	Soil Sample	Road cut/Zone 3
	Soil Sample	Road cut/Zone 4
	Soil Sample	Trench 1/Zone 5
	Soil Sample	Trench 1/Zone14
	Soil Sample	Trench 6/Zone 3
	Soil Sample	Trench 6/Zone 5
	Soil Sample	Trench 6/Zone 8
XRF Analysis	Obsidian	Surface (P# 11)
	Obsidian	Surface (P# 16)
	Obsidian	Surface (P# 32)
	Obsidian	Surface (P# 48)
	Obsidian	Surface (P# 113)
	Obsidian	Surface (P# 260)
INAA Analysis	Jornada Brown	LCAS 201-1
	Jornada Brown	LCAS 201-2
	Jornada Brown	LCAS 201-3
	South Pecos Brown	LCAS 202-1
	South Pecos Brown	LCAS 202-2
	Mimbres	LCAS 461-1
	El Paso Polychrome	LCAS 461-2
	Chupadero Black-on-white	LCAS 513-1
	Chupadero Black-on-white	LCAS 523-1
	Jornada Brown Rim	LCAS 535-1
	Chupadero Black-on-white	LCAS 536-1
	Chupadero Black-on-white	LCAS 536-2
	El Paso Polychrome	LCAS 542-1
	Corona Corrugated	LCAS 558-1
	El Paso Polychrome Rim	LCAS 582-1
	Corona Corrugated	LCAS 657-1

[redacted] Previous investigations at the site uncovered evidence for one or more occupations dating to the early/middle Archaic through the late Formative period, with site use indicated by semi-rectangular shaped pit houses, fire-cracked rock features, middens, and dense artifact scatters. It is suspected that the period between A.D. 1100 and 1350 reflects the greatest intensification in site use, with site abandonment occurring by A.D. 1350.

The site has been recorded and updated three times beginning in 1971 (Runyan 1971) by the LCAS, followed by ENMU-ACA (Haskell 1977), and Laumbach et al. (1979) Laguna Plata Archaeological District Evaluation project. However, of the three projects, only the LCAS (Runyan 1971) and Laumbach et al. (1979) directly relate to LA 5148 as it currently exists.

9.1.1 Lea County Archaeological Society Excavations at C-10-C

The LCAS conducted excavations at C-10-C, LA 5148, between September 15, 1970 and January 31, 1971 on a small, but prominent knoll along the western margin of Laguna Plata. This knoll falls within the northwestern boundary of the current site, well within the basin interior. A Cartesian grid was superimposed over the knoll, dividing the site into four unequal quadrants (Figure 9.1). The site datum was positioned at the zero East -zero North coordinate, with grid provenience taken from the southwest corner of each 5 x 5-ft grid unit. Each unit was given a numerical value correlated with its direction from the datum. For example, 6S/3E, indicates the sixth 5 ft x 5-ft unit south of the datum and the third unit east of the datum. Viewed another way, this unit is 30 ft south and 15 ft east of datum. Subsequently, 46 5 ft x 5-ft units were excavated by LCAS reaching an average of 16 inches (4 cm) below ground surface (bgs). Test units were excavated in 4 inch (10 cm) arbitrary levels within a natural midden deposit, generally terminating when the underlying alluvium (7.5YR 7/3, pink clay loam) was exposed. Three features were identified and excavated during the course of their fieldwork.

Feature 1 consisted of 21 postholes exposed in a linear pattern within a 15 x 10-ft block unit. These postholes were intrusive into the underlying reddish brown (5YR5/4, reddish brown) alluvium thought to have been added to the terrain to establish a floor or platform for Feature 1. This possible structure was impacted by vandalism, which removed the eastern half of the pit house. No internal features were noted during excavation, however, a concentration of bone fragments, containing more than 150 unbroken and broken mammal bones, were exposed about 1 ft (30 cm) east of the postholes (Runyan 1971:7).

Feature 2 consisted of a semi-rectangular outline of 51 postholes encompassing a 7.6 ft x 9.5-ft (2.31 x 2.89-m) area. The postholes, spaced in pairs, probably formed the support structure of the pit house. In a similar fashion to Feature 1, no internal features were present; however, a concentration of ash and carbon-stained sediments was identified immediately east of the structure. Again, the 1971 interpretation of the reddish brown (5YR5/4) deposit was one of a prepared floor deposited to serve as a platform to build the structure. One wood charcoal sample was collected from the floor of the structure. The intention was that this sample be submitted for radiocarbon analysis, however, no mention of the findings have ever been reported. Following the feature excavation, the pit house was covered with plastic and buried with backfill (Runyan 1971:7).

Feature 3 exposed in a 15 x 15-ft unit, was a semi-rectangular pit house. This structure contained 31 postholes that formed an 8.3 x 10.5-ft (2.53 x 3.20-m) structure. Two cedar post remnants, designated Post No.1 and No. 2, were documented just outside the northwest margin of the structure (Runyan 1971:11). As noted in Runyan (1971:12), Feature 3 was badly disturbed by bioturbation and animal burrows, preventing a clear outline of the pit house. In a similar fashion to Feature 2, Feature 3 was also interpreted as intrusive into the underlying clay platform. No artifacts or internal hearths were exposed during the excavation of Feature 3.

The LCAS excavations recovered 4,640 artifacts from LA 5148 as defined by site number C-10-C (Runyan 1971). Most of artifacts were collected from the anthrosol that covers Features 2 and 3. Lithic debitage collected totaled 2,357 pieces, along with 24 retouched flaked stone tools, and 76 pieces of modified debitage. In addition, 25 unbroken projectile points and 46 projectile point fragments were recovered. Five hammerstones and seven manos were also collected. The ceramic assemblage included 435 pottery sherds, consisting of at least nine stylistically distinct types. The faunal assemblage included 1,648 pieces of bone, as well as 2 bone awls and 13 shell fragments. One shell bead was also collected.

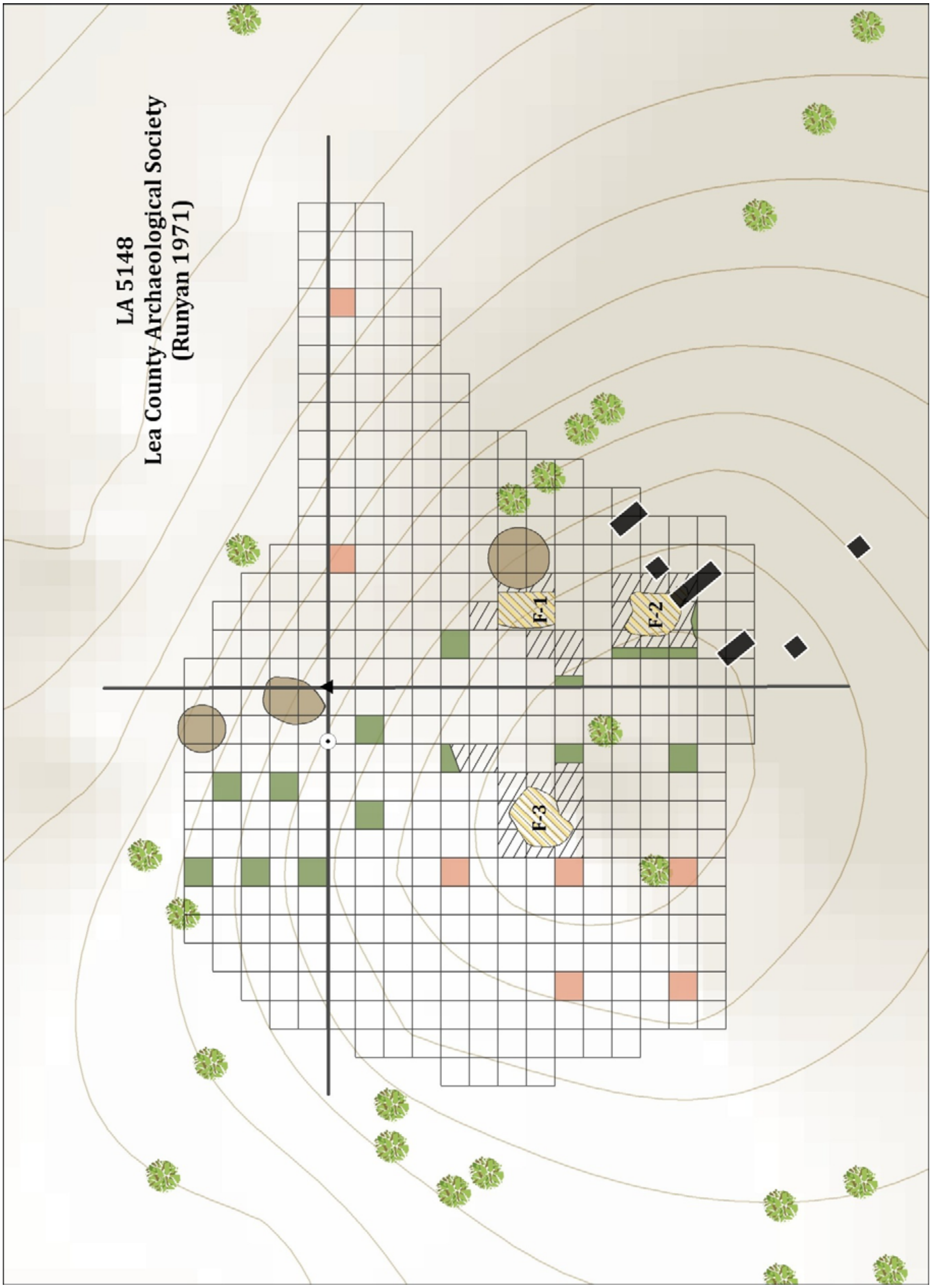

Figure 9.1 Map showing the LCAS and ENMU-ACA excavation areas
(inset are Features 2 and 3 as documented in Runyan [1971])

9.1.2 Eastern New Mexico University Feature 1 Test Excavations

The ENMU excavations targeted four areas of ENM10017, as defined in 1975, which encompassed the southeast portion of the LCAS excavation area, as well as area to the south and west of the current LA 5148 boundary (1975, field notes archived at ENMU, Portales, New Mexico). Test Area 1 included the southeastern portion of the LCAS area C-10-C (see Figure 9.1). Test Area 2 consisted of six 1 x 1-m units along a low rise approximately 100 m south of Test Area 1. Test Area 3 consisted of 11 1 x 1-m units along the ridge west of LA 5148. Test Area 4 targeted an area just north and south of the two-track access road that accesses the basin. Two 1 x 1-m units were excavated in this area with sandstone mortars. For the purposes of this project, only Test Area 1 is discussed.

Test Area I consisted of ten 1 x 1-m units that were in the southeastern portion of the LCAS C-10-C site area of LA 5148. Commonly referred to, in the ENMU field notes, as the 'midden site location', or the 'midden site', excavations were carried out over a three-day period. Eight of the 1 x 1-m were excavated within the C-10-C boundary, while two were along the southeastern boundary. All of the units exposed anthrosol deposits, with one unit possibly exposing the LCAS Feature 2 excavation block. During the course of the excavation, five distinct strata were documented. Stratum A was defined as disturbed midden/anthrosol or possibly backfill from the LCAS excavation. This deposit was exposed in ENMU Units 7 through 9. Stratum B was described as windblown sediments and was identified in ENMU Units 4 through 10. Stratum C was interpreted as intact midden or anthrosol, and was documented in all ten of the ENMU test units. Underlying Stratum C was the reddish-colored clay matrix interpreted as 'house-floor'. This deposit was designated Stratum E and was highly disturbed by rodent activity and bioturbation when encountered. Stratum E was present in ENMU Units 1 and 4. Underlying Stratum E was a sterile white/gray colored clay horizon identified as Stratum D. Stratum D was consistently identified in ENMU Units 1, 2, 6, 7, 8, 9, and 10. ENMU Unit 1 may have exposed a portion of the LCAS block unit with Feature 2, however, based on the provenience data, this is uncertain.

ENMU-ACA identified three clusters within the LCAS excavation area. Identified as Cluster A, B, and C, these aggregation areas are in the southern and southeastern portions of C-10-C and were compiled from the LCAS excavation assemblages. The three clusters do not correspond with the LCAS excavation units, and consequently, the relationship between three clusters and C-10-C is unclear. These assemblages do however, represent a subset of the total collections recovered during the LCAS excavation and were subdivided according to the depth at which they were collected. Hence, Z correlated with the ground surface. Levels A through G corresponded with 4 -inch arbitrary excavated levels. Cluster A consisted of 1,044 lithic artifacts, Cluster B included 529 artifacts, and Cluster C contained 427 artifacts. Outside the aggregation areas, but within the boundary of C-10-C yielded 534 artifacts (Haskell 1977:176).

The ceramic assemblage collected by LCAS and analyzed by Haskell (1977:275) consisted of 375 items. Attempts to divide the ceramic assemblage into distinct occupational units or phases was largely unsuccessful, however, individual sherds were assigned a stratum designation in much the same fashion as the lithic assemblage. Collectively, most sherds were recovered from Stratum Z, or the surface (n=114). Stratum A, reflecting a depth range of 10 cm bgs also contained 114 sherds. Strata B through F included 80 sherds recovered from 10–60 cm bgs (Haskell 1977:278).

9.2 TRC Archaeological Testing Results (Phase I)

TRC initiated testing at LA 5148 on April 20, 2010 and completed the fieldwork on April 27, 2010 (Figure 9.2). Testing consisted of site mapping, surface collecting, geophysical survey, and geomorphological investigations. Phase I of testing consisted of establishing the site boundaries, identifying the LCAS site datum, establishing a TRC datum and correlating the TRC grid of true north with the LCAS grid system of magnetic north. Site boundaries were established using site documentation provided by the BLM-CFO. Electronic shape (.shp) files of the site were uploaded onto a Trimble GeoXT

GPS receiver with ArcPad GPS software and the site boundaries were delineated using solid orange flagging tape.

A datum, consisting of rebar tagged with the site number, was established at the site. The position of the datum was also recorded with a Trimble GeoXT global positioning retriever. A UTM coordinate of easting and northing (NAD 83) and elevation was assigned to the datum, creating a grid system of UTM values. All grid coordinates were mapped with an electronic distance measurer (Nikon DTM 652) and tied into the overall grid system.

All features were documented, trowel tested, assigned a point provenience, and mapped. Forty-six features were discerned. Due to the large number of artifacts, TRC in consultation with the BLM-CFO employed a 10 percent, or 1 in 10 random sampling strategy. In order to accomplish this task, LA 5148 was surveyed using parallel linear transects spaced at 10-m intervals. Artifacts were pin flagged with every tenth artifact assigned a point provenience and limited descriptive recording. As a result, 1,533 artifacts were mapped across the site. This assemblage included 20 pieces of pottery, 34 hammerstones, 38 shell fragments (including one shell bead), 94 pieces of bone, 183 ground stone artifacts, 190 pieces of burned caliche, and 974 flaked-stone artifacts. Thirty-three of these artifacts were collected. The resulting data provided a representative sample of artifact types and densities across the site.

Following the site documentation, a geophysical survey was conducted by Sunbelt Geophysical of Socorro, New Mexico. The purpose of the geophysical investigation was to verify the location and extent of the LCAS Features 2 and 3 excavation units. Geophysical survey was conducted using a magnetometer, a ground conductivity meter, and ground penetrating radar. The fieldwork was carried out on April 22 and 23, 2010. A 25 x 2-m grid was superimposed over the LCAS C-10-C excavation area and tied into the LCAS datum. In addition, two sub areas, consisting of a 10 x 14-m and a 20 x 6-m, were surveyed immediately north of the two-track access road. Results of the survey revealed anomalies in the general vicinity of Features 2 and 3. These geophysical signatures provided a general depth and outline of the LCAS excavation areas associated with Features 2 and 3 and substantiated the accuracy of the LCAS site map.

Mechanical trenching was used to further expose the stratigraphic sequence across the site and facilitate feature discovery in portions of the site where the testing results for cultural deposits were ambiguous or poorly defined. Phase I of the testing entailed eight backhoe trenches placed northeast of the LCAS excavation area, across the west-central boundary of the site, and off site along the southeastern margin of the playa. On average, each trench was minimally 10 m long and had a minimum depth of 80 cm bgs. The exposed soil profiles varied across the site and are summarized in Section 11.0. In addition, four cores were done across the LCAS excavation area. The cores, spaced 5 m apart, were along a single north/south transect that tied into the LCAS datum.

9.2.1 Testing Level of Effort (Phase II)

Testing included the excavation of one 4 x 4-m unit, one 5 x 5-m unit, and a 1 x 0.50-m unit (41 m^2). The total level of effort expended at the Laguna Plata site 111 m^2. The scope of work called for the excavation of 30 1 x 1-m excavation units. Table 9.2 presents a summary of the data-recovery effort. The cultural assemblage recovered from testing consisted of 238 artifacts. All surface cultural materials (n=1,532) were assigned a provenience point and mapped, of which 38 diagnostic items were collected for further analysis (Table 9.1).

Horizontal control of manual excavations was by 1 x 1-m units. Stratum I was excavated as a natural level usually associated with overlying modern aeolian sand deposits. Subsequent soil horizons were designated consecutive numerical values (Stratum II-Level 1, Stratum III-Level 1, etc.) which were later correlated with the stratigraphic series for the site. Exposing Features 2 and 3 included Stratum I-aeolian sands, Stratum II-LCAS backfill, and Stratum III-reddish/orange alluvium. Feature 6, a pit feature south of the LCAS project area, was excavated. Feature 6 was on the present ground surface and intruded into the underlying Ab and B soil horizon.

Table 9.2 Summary data for level of effort at LA 5148

Excavation Unit No.	Unit Size (m)	Total (m^2)
1	4 x 4	16
2	5 x 5	25
3	1 x 0.5	0.5
Manual Excavation		41.5
Mechanical Excavation		80
Total Effort Expended		121

Once exposed, Features 2 and 3 were documented. Data regarding dimensions, construction details, possible chronological age, and function were collected. Samples, including carbon-stained sediment and wood charcoal, were recovered in the form of charred posts. These samples were submitted for macrobotanical and AMS radiocarbon dating. Feature fill and wood charcoal from Feature 6 was also collected and submitted for macrobotanical and AMS dating. As no feature fill was present in Features 2 and 3, no sediment samples were processed. Soil samples from Feature 6 were processed by flotation, and light fractions were submitted for macrobotanical analysis.

9.2.2 Assemblage Survey Results

A representative sample of 1,532 surface artifacts was recorded (Table 9.3). This assemblage, primarily targeted for spatial data, received limited in-field analysis beyond assigning a provenience point. Twelve artifact categories were recorded during site survey. The flaked-stone assemblage included complete flakes (n=516), angular debitage (n=311), modified debitage (n=27), bifaces (n=9), and projectile points (n=6). In addition, cores (n=101) and tested cobbles (n=4) were included in this category. Thirty-four hammerstones were also recorded. The ground stone assemblage included a pestle fragment (n=1), manos and mano fragments (n=30), metates and metate fragments (n=42), and indeterminate ground stone fragments (n=110). Ceramics (n=20) while present, did not constitute a large portion of the sample assemblage. This may be the result of visibility or perhaps, through years of local collection, the frequency of ceramics has decreased, reflecting a smaller artifact group from which to sample.

Six pottery types were recorded during the site survey. Local ceramics included brownware variants of Jornada Brownware (n=1), El Paso Brown (n=2), El Paso brownware (n=10), decorated brownware (n=3), and indeterminate brownware (n=3). A corrugated brownware sherd (n=1) was also documented. In addition, a single Chupadero Black-on-white sherd was recorded. Mollusk shell fragments (n=38) were mapped, including one shell bead. Ninety-four unmodified, burned, and calcined small mammal bone fragments were documented.

Table 9.3 2010 assemblage summary data (n=326) for LA 5148

Provenience	Artifact Type	Artifact Number (n=)	Frequency (%)
Test Unit 1	Complete Flakes	75	43.6
	Lithic Debitage	41	23.8
	Modified Debitage	2	1.2
	Biface	1	0.6
	Tested Cobble	3	1.7
	Hammerstone	1	0.6
	Ground Stone	1	0.6
	Ceramics	10	5.8
	Bone	38	22.1
Test Unit 2	Complete Flakes	63	54.3
	Lithic Debitage	43	37.1
	Hammerstone	2	1.7
	Ground Stone	3	2.6
	Ceramics	3	2.6
	Bone	2	1.7
Surface Collection	Unifaces	2	5.3
	Lithic Debitage	11	28.9
	Modified Debitage	1	2.6
	Projectile Points	6	15.8
	Mano	1	2.6
	Ground Stone	1	2.6
	Bead	1	2.6
	Ceramics	15	39.5

Table 9.4 Summary of surface diagnostic artifacts

FS No.	Quantity	Artifact Description	[redacted]
686	1	Jornada brownware	
687	1	Jornada brownware	
688	1	Jornada Brown Rim	
688	2	Flakes	
689	1	Modified Flake	
690	1	Chupadero Black-on-White	
690	1	Flake	
691	1	Jornada brownware leg	
692	1	Flake	
693	1	Jornada brownware	
694	1	Unknown Painted Monochrome	
695	1	Jornada brownware	
695	1	Flake	
696	1	Flake	
697	1	Projectile Point	
698	1	Corona Corrugated	
699	1	Unknown Painted Monochrome	
700	1	St. John's Polychrome	
701	1	Corona Corrugated Rim	

FS No.	Quantity	Artifact Description	[redacted]
702	1	Possible Unimarginal	
703	1	Flake	
704	1	Flake	
705	1	Uniface	
706	1	Gila Polychrome Rim	
707	1	Flake	
708	1	Gila Polychrome Rim	
709	1	Flake	
710	1	Mano	
711	1	St. John's Polychrome	
711	1	Flake	
713	1	Bead	
715	1	Ground stone	
719	1	Projectile Point	
720	1	Projectile Point	
721	1	Projectile Point	
722	1	Projectile Point	
723	1	Projectile Point	

9.2.3 Features

All 43 features were documented with attention to metric dimension, content, and contextual integrity (Table 9.4). Most of the features were defined as informal pit houses or classified as domestic features following Condon et al. (2008b) and Hogan (2006). Domestic features were typed as pit houses, hearths, burned-caliche cobble concentrations, or burned-caliche scatters. Two additional feature types were included in this study: the artifact concentrations and the middens. Of the 43 features identified, two (4.65 percent) were typed as pit houses, three (6.97 percent) burned-caliche concentrations, four (9.30 percent) artifact concentrations, and eight (18.60 percent) as burned-caliche scatters. One (2.32 percent) feature was interpreted as an artifact midden. Hearths, however, occurred with the highest frequency at LA 5148. Hearths were defined as a subterranean pit with or without associated burned rock. Seven (28 percent) hearths are carbon stains with no burned rock. The remaining 18 (72 percent) hearths exhibit a variety of dimensions, but all contain carbon-stained sediments with depth and burned-caliche cobbles. Interestingly, 20 (80 percent) hearths also contained associated ground stone. Eleven (44 percent) hearths included small calcined or burned bone fragments. Many of the hearths are interspersed among larger artifact concentrations, particularly common in the south half of the site. In a similar fashion, burned-caliche scatters most often were on paleosol surfaces along the ridge margins where deflation and erosion were greatest. Due to the lack of contextual integrity, burned-caliche cobble scatters were difficult to interpret with the greater site area.

Artifact concentrations were almost exclusively limited to ground stone clusters. These features were most frequently in the southern portion of the site where naturally occurring sandstone outcrops were exposed along the deeply incised arroyos. Middens consisted of dense artifact concentrations intermixed with an organic rich anthrosol. This feature type was easily recognized southeast of the LCAS excavation area, in the northern portion of LA 5148. Finally, two pit houses, designated as Features 2 and 3, were reexamined during the course this testing project.

Table 9.5 Feature data summary for LA 5148

Feature No.	Feature Dimensions (m)	Feature Attributes	Associated Artifacts	Contextual Integrity
1	n/a	Partial pit house	n/a	Not excavated
2	3 x 2.9	Pit house		Subsurface
3	3.6 x 3.2	Pit house		Subsurface
4	1 x 1	Burned-caliche cobble concentration w/ 100+ burned cobbles	n/a	Surface/paleosol
5	0.8 x 0.6	Carbon Stain w. five burned-caliche cobbles	Ground stone fragments, burned-bone fragments, and lithic debitage	Subsurface ~0.10 m w/ larger artifact scatter
6	0.37 x 0.65	Pit feature (carbon staining)	Wood charcoal fragments	Exposed in the south wall of a well-incised arroyo.
7	15 x 21	Large burned-rock scatter w/ 60+ burned-caliche cobbles/ carbon staining	Ground stone fragments, lithic debitage, core, shell fragments, and bone fragments	Subsurface ~0.10 m w/ larger artifact scatter
8	5 x 5	Burned-caliche scatter w/ 100+ burned cobbles/artifact concentration	Ground stone fragments (< 100), lithic debitage (<100)	Surface/paleosol
9	8 x 5	Burned-caliche scatter w/ 25 burned cobbles w/ artifact scatter/carbon-stained sediments	Ground stone fragments (30+), lithic debitage, core, and clear glass	Subsurface ~0.10 m w/ larger artifact scatter
10	16 x 9	Large midden w/ carbon-stained sediments (200+BC cobbles)	Ground stone fragments. lithic debitage, shell fragments, and calcined bone fragment	Subsurface ~0.05 m/ with artifact scatter
11	1.2 x 1.1	Carbon Stain within artifact scatter	Ground stone fragments and lithic debitage	Subsurface ~0.10 m w/ small artifact scatter
12	0.25 x 0.3	Carbon Stain w/ 7 burned-caliche cobbles	Ground stone fragments and lithic debitage	Subsurface ~0.05 m/ with small artifact scatter
13	0.3 x 0.3	Carbon Stain within artifact scatter	Ground stone fragments. lithic debitage, brownware sherds, and calcined bone fragment	Subsurface ~0.05 m/ with large artifact scatter
14	0.15 x 0.2	Carbon Stain within artifact scatter	Ground stone fragments, lithic debitage, shell fragment, and burned-bone fragments	Subsurface ~0.05 m, w/ wood charcoal
15	0.25 x 0.25	Carbon Stain within artifact scatter w/ <10 burned-caliche cobbles	Ground stone fragments, lithic debitage, calcined and burned-bone fragments	Subsurface ~0.05 m,
16	0.15 x 0.15	Carbon Stain within artifact scatter/ 6 burned-caliche cobbles	Ground stone fragments, lithic debitage, and browned bone fragments	Subsurface ~0.05 m
17	1 (diameter)	Ground Stone and Burned-Caliche Cluster w/ carbon-stained sediments	Ground stone fragments (30+), burned-caliche cobbles (35), and calcined bone fragments	Subsurface ~0.10 m

Feature No.	Feature Dimensions (m)	Feature Attributes	Associated Artifacts	Contextual Integrity
18	0.2 x 0.2	Carbon Stain w/ 60 small burned-caliche fragments	Ground stone fragments, lithic debitage, and bone fragments	Subsurface ~0.05 m
19	0.15 x 0.2	Carbon Stain	Lithic Debitage	Subsurface ~0.05 m
20	0.3 x 0.3	Carbon Stain w/ 10 burned-caliche cobbles	Lithic debitage and ground stone fragments	Subsurface ~0.05 m
21	1 x 1	Burned-caliche cobble scatter (~20)	n/a	Surface
22	1.5 x 2	Burned-caliche cobble (~15) and ground stone cluster w/ carbon-stained sediments	Ground stone fragments (~40), lithic debitage, and calcined/burned bone fragments	Subsurface ~0.10 m
23	3 x 2	Burned-caliche concentration (~20) w/ carbon-stained sediments	Lithic debitage and ground stone fragments	Subsurface ~0.10 m
24	0.25 x 0.25	Carbon Stain	n/a	Subsurface ~0.05 m
25	0.2 x 0.2	Carbon Stain w/ 2 burned-caliche cobbles	n/a	Subsurface ~0.05 m
26	0.2 x 0.2	Carbon Stain w/ 3 burned-caliche cobbles	Lithic debitage and ground stone fragments	Subsurface ~0.05 m
27	0.15 x 0.2	Carbon Stain w/ 5 burned-caliche cobbles	Lithic debitage and ground stone fragments	Subsurface ~0.05m,
28	0.35 x 0.3	Carbon Stain w/ 4 burned caliche-cobbles	Ground stone fragments (10), lithic debitage (5), shell fragment, and burned bone fragments	Subsurface ~0.10 m w/ wood charcoal
29	5 x 8	Large artifact scatter w/ ~70 Burned-caliche cobbles	Lithic debitage and ground stone fragments	Surface
30	3 x 2	Ground stone cluster w/ 11 burned-caliche cobbles	Ground stone artifacts (33+), lithic debitage, and bone fragments	Surface
31	1 x 0.55	Carbon Stain w/ 5 small burned-caliche gravels	Ground stone fragments, lithic debitage, and bone fragments	Subsurface ~0.10 m-eroding out from dune
32	13 x 11	Artifact scatter w/ 50+ burned-caliche cobbles	Ground stone fragments (20+), lithic debitage (50+), and bone fragments	Surface
33	0.35 x 0.3	Carbon Stain w/ < 10 burned-caliche fragments	n/a	Subsurface ~0.05 m-eroding out from small arroyo
34	4 x 4	Artifact and burned-caliche cobble scatter (~20)	Ground stone fragments (15+) and lithic debitage (25+)	Surface
35	3 x 4	Artifact and burned-caliche cobble scatter (~10)	Ground stone fragments (10+) and lithic debitage (13+)	Surface
36	4 x 2	Burned-caliche cobble scatter (16+)	Ground stone fragments (18)	Surface w/in larger artifact scatter
37	0.5 x 0.5	Carbon Stain	Ground stone fragments (4)	Subsurface ~0.05 m-w/in basin

Feature No.	Feature Dimensions (m)	Feature Attributes	Associated Artifacts	Contextual Integrity
38	1 x 1.5	Burned-caliche concentration (50+)	Ground stone fragments (11) and lithic debitage	Surface
39	5 x 3	Burned-caliche scatter (21)	Ground stone fragments (30), lithic debitage	Surface
40	0.35 x 0.4	Burned-caliche cluster (8) with ground stone fragments	Ground stone fragments (6), 3 metate fragments, lithic debitage	Surface
41	1.50 x 2	Ground stone concentration	Ground stone fragments (15), metate fragments (24), burned-caliche cobbles (2)	Surface
42	0.26 x 0.22	Carbon Stain w/ 3 burned-caliche cobbles	Ground stone fragments (3)	Subsurface ~0.03 m-w/in basin (shallow)
43	6 x 3.4	Ground stone cluster	Metate fragments (20), indeterminate ground stone fragments (6)	Exposed in south facing dune
44	7 x 3	Ground stone cluster	Metate fragments (~15), indeterminate ground stone fragments (~60)	Exposed along margin of dune and along sloping paleosol

Following the treatment plan, two units were placed over Features 2 and 3, respectively. Feature 2 was 2.31 x 2.89-m and consisted of a shallow pit house. Feature 3 was 3.60 x 3.20-m and consisted of a shallow pit house. Feature 6 was a 0.37 x 0.23-m pit with carbon-stained sediments and wood charcoal.

9.2.3.1 Test Unit 1 (Feature 2)

Test Unit 1, a 4 x 4-m unit in the south-central portion of the LCAS C-10-C site area, was placed over LCAS Feature 2 (Runyan 1971). Using the results of the GPR survey and coordinates derived from the 1970 grid system, this unit was placed 17 m south of the LCAS datum and 1.52 m west from the north/south LCAS grid line (NW corner of unit). From this coordinate, a 3 x 3-m unit was established within the LCAS 15 x 15-ft excavation block, encompassing Feature 2 (Figure 9.3). A subdatum was established 23 cm above ground surface at the northwest corner of the unit.

The landscape associated with Test Unit 1 gradually slopes to the south-southeast and is differentially blanketed with aeolian sediments and small patches of grass and creosote bush. A mottled yellowish brown-to-dark brown (10YR 5/4, 7.5YR 4/2) anthrosol covers much of the test unit and is visible at the ground surface. This anthrosol, noted in Runyan (1971) as a midden, is sporadic in exposure, and has darker organic properties that make it stand out against the aeolian sands.

Figure 9.3 Test Unit 1, Stratum II/III contact showing LCAS plastic sheeting covering Feature 2

(Note post holes along the western margin of unit)

The 16 1 x 1-m units comprising Test Unit 1 had the overlying aeolian sediments (Stratum I) removed as a natural level and screened through 1/8-inch hardware mesh. These surface sediments were yellowish brown (10YR 5/4), unconsolidated, with small gravels. One quartzite tested cobble and three sandstone metate fragments were recovered from Stratum I. Four burned-caliche cobble fragments were noted within the test unit. Stratum I ranged in depth from 3–11 cm bgs. At the Stratum I/II contact, a patchy matrix of dark and light soils (10YR 5/4, yellowish brown; 7.5YR 4/2, dark brown) was noted. This mottled deposit is backfill from the LCAS excavation of Feature 2.

The Stratum II deposit ranged in depth from 11–39 cm and terminated when clear plastic sheeting covering Stratum III, the reddish brown (5YR 4/4, reddish brown) alluvial horizon was encountered. The plastic sheeting was documented in Runyan (1971) and provided a definitive marker for identifying the Stratum III contact. In much the same manner as Test Unit 2, which was excavated concurrent with Test Unit 1, Stratum II was determined to be backfill from the LCAS excavation. This was confirmed by Charles Frederick, project geomorphologist. As a result, Stratum II was excavated as a natural deposit with sediments judgmentally selected for screening until the Stratum II/III contact was exposed.

Subsequent to the plastic sheeting being uncovered, photographs were taken. The plastic sheeting was carefully removed north to south and each posthole cleared of plastic-sheeting fragments and back fill sediments. The pit house floor as it was documented in 1970 was exposed.

The cultural assemblage recovered from Test Unit 1 included 134 artifacts, the majority collected from the LCAS backfill. The flaked-stone assemblage consisted of one biface, two modified flake fragments, and 116 pieces of debitage. In addition, one quartzite hammerstone and three tested cobbles (quartzite) were also recovered. One sandstone indeterminate ground stone fragment was collected from Stratum II-LCAS backfill. The ceramic assemblage consisted of one Jornada Brown sherd, four El Paso brownware sherds, and five Chupadero Black-on-white sherds.

9.2.3.2 Feature 2

Feature 2 was a clearly defined, semi-rectangular 3 x 2.9-m (9.84 x 9.51-ft) pit house, slightly increasing in area from the 2.31 x 2.89-m (7.6 x 9.5-ft) recorded in Runyan (1971) (Figures 9.4). Consistent with the Runyan (1971), no internal hearths were identified during the 1970 excavation, or during the current testing; however, a possible external hearth was identified about 76 cm (2.5 ft) east of the pit house boundary. Utilizing the LCAS data, TRC examined the locus where the hearth was mapped. The hearth area was disturbed by rodents, and, no evidence of an intact hearth remained.

Fifty-two postholes were mapped and recorded in Runyan (1971), but only 26 were discerned during the current testing project. The postholes outlined the structure and established the size and morphology of the pit house. Two charred wooden posts were documented by Runyan (1971). One was removed by LCAS in 1970 and the other was left untouched (Runyan 1971:12). This charred post was in poor condition, but still present, when TRC exposed the pit house. After being documented and photographed, this post remnant was collected and submitted for AMS radiocarbon dating. The resulting AMS analysis yielded a noncalibrated age of 1740±25 B.P. (UGA 6724) and a calibrated age range of A.D. 230 and 390 B.C. (OxCal Version 3.1). This age estimate is earlier than expected for site use than supported by the projectile point and ceramic assemblages.

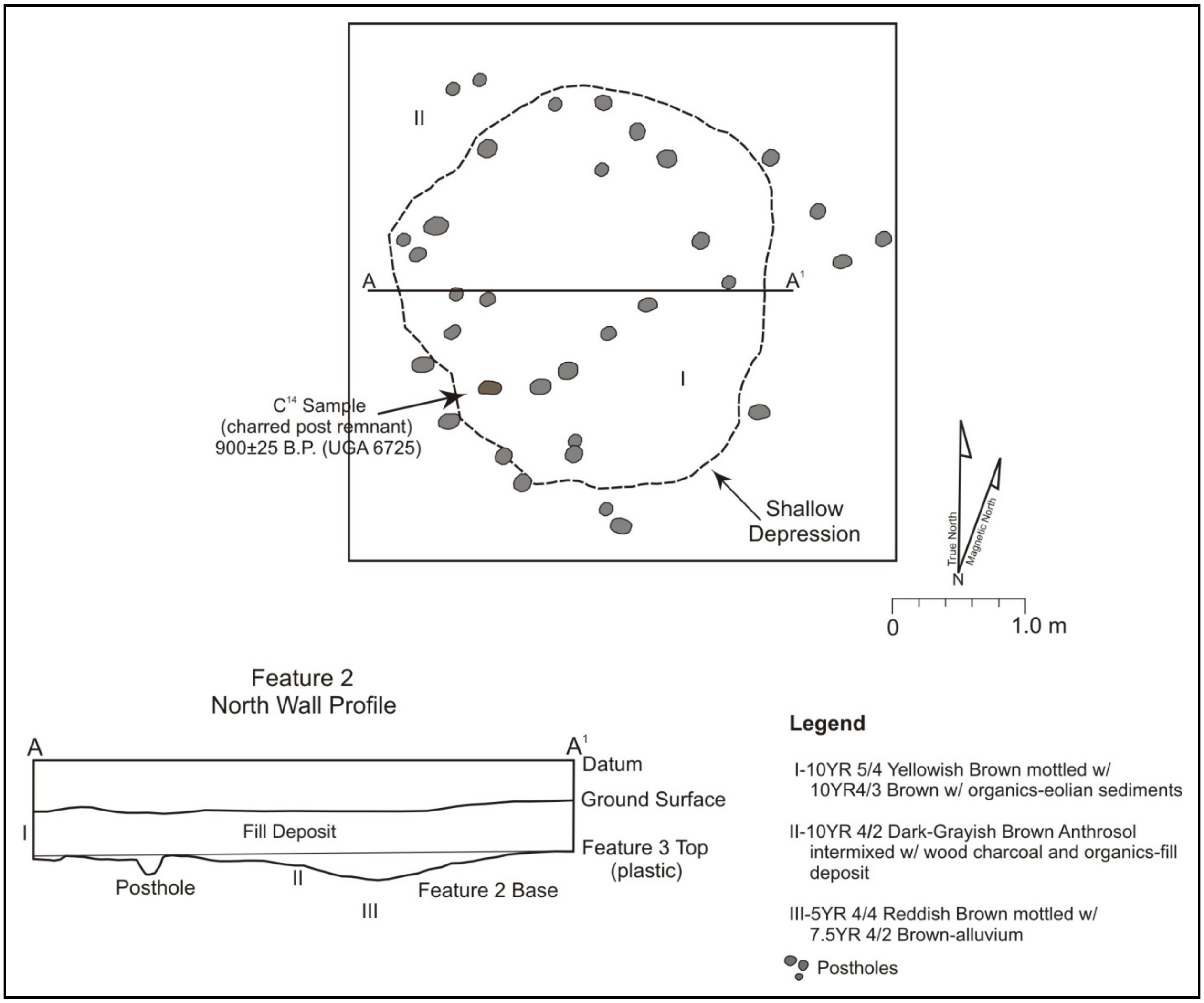

Figure 9.4 Test Unit 1-Feature 2 plan view and pit house cross-section profile

9.2.3.3 Test Unit 2 (Feature 3)

Test Unit 2, a 5 x 5-m unit in the southwestern portion of the LCAS C-10-C site area, was placed over LCAS Feature 3 (Runyan 1971). This test unit replicated the original 15 x 15-ft unit used to excavate Feature 3 in 1970 and was aligned to true north with the feature positioned in the center of the unit. Using the results of the GPR survey and coordinates derived from the 1970 grid system, Test Unit 2was placed 10 m south of the LCAS datum and 3 m west from the north/south LCAS grid line (Runyan 1971). From this coordinate, a 5 x 5-m unit was re-established (the NW corner being 5 m west) over the 1970 excavation block. A subdatum was established 15 cm above ground surface at the northwest corner of the unit (Figure 9.5).

The landscape associated with Test Unit 2 gradually slopes to the south and is differentially blanketed with aeolian sediments and small patches of grass and creosote bush. A mottled yellowish brown-to-brown (10YR 5/4, 10YR 4/3) anthrosol covers much of the test unit area and is visible at the ground surface. This anthrosol is noted in Runyan (1971) as a midden and as a ‘dark, man induced organic soil’ in Haskell (1977:110).

The 25 1 x 1-m units comprising Test Unit 2 had their overlying aeolian sediments (Stratum I) removed as a natural level and screened through 1/8-inch hardware mesh. These surface sediments were yellowish brown (10YR 5/4), unconsolidated, with small gravels.

Figure 9.5 Test Unit 2 showing the interface between Stratum II/III, and the irregular outline of Feature 3

(Note postholes in the southeast and north-central, and northeast portions of the unit)

One brownware sherd and one piece of lithic debitage was recovered from Stratum I. At the Stratum I/II contact, a patchy matrix of dark and light soils (10YR 5/4, yellowish brown; 10YR 4/3, brown) were noted. In particular, the northwest corner contained a dark colored deposit that stood out from the rest of the unit.

As the relationship between Stratum II and the fill deposit was unclear, a 1 x 1-m unit was established 1 m south and 1 m west along the east border of Test Unit 2. The Stratum II deposit was excavated 46 cm and terminated when Stratum III, the orange/red (5YR 4/4, reddish brown) alluvial horizon was encountered. This orange alluvium correlated with the pit house clay pad identified by LCAS (1971). When reviewing the east and south wall profiles of this 1 x 1-m unit, it became clear that TRC's Stratum II was backfill from the LCAS 1971 excavation. Charles Frederick, project geoarchaeologist, confirmed the depositional context of Stratum II, which was present throughout Test Unit 2. As a result, Stratum II was excavated as a natural deposit with sediments judgmentally selected for screening until Stratum III was exposed and Feature 3 became discernible. As Feature 3 had been excavated 40 years earlier, and not covered with plastic, only the backfill was discernible at the Stratum II/III interface, which stood out when compared to the orange red Stratum III. After being photographed and drawn in plan view, the remaining 13 cm of back fill was carefully removed from Feature 3, exposing the floor of the pit house. One arbitrary 10 cm level was excavated in a 1 x 1-m unit along the north wall of Test Unit 2. This level exposed Stratum IV, a pink (7.5YR 7/3), compact calcium-rich horizon that underlies Stratum III. This deposit was screened through 1/8-inch hardware mesh and no cultural materials were recovered.

Test Unit 2 yielded 114 artifacts. The artifact assemblage included two quartzite hammerstones and 106 pieces of lithic debitage. In addition, one metate fragment and two manos were recovered from the

Stratum II-LCAS backfill. Three pottery sherds were recovered, including one Corona Corrugated sherd and two Jornada Brown sherds. The paucity of artifacts is not surprising as the unit excavation was removing backfill from 1970. TRC recovered Styrofoam, cigarette filters, and Benson and Hedges cigarette packets at the Stratum II/III interface.

9.2.3.4 Feature 3

Feature 3 was a poorly defined, irregularly-shaped 3.6 x 3.2-m (11.81 x 10.5-ft) pit house, slightly increasing in area from the 2.53 m x 3.20 m (8.80 ft x 10.50 ft) recorded in Runyan (1971) (Figure 9.6). Consistent with Runyan (1971), no internal hearths were identified during the 1970 excavation, or during current testing. However, 19 postholes—18 of which were previously excavated—were identified along the outer margin of Feature 3. These postholes defined the eastern and southern boundary of the structure. One of two wooden posts documented in the northwest portion of the test unit by Runyan (1971) was present, but in poor condition. The wood charcoal identified 40 years ago was no longer present with only an outline of the post remaining. The poor condition may be the result of bioturbation or rodent disturbances that are present throughout the test unit and the pit house. Three posts—A, B, and C—retained charred wood fragments. Each was mapped in plan view and collected for further analysis. Post C was in the north-central portion of the unit (Figure 9.7). After being documented and photographed, Post C was collected and submitted for AMS radiocarbon dating. The resulting AMS analysis yielded a noncalibrated age of 900±25 B.P. (UGA 6725) and a calibrated age range of A.D. 1040 and 1220. This age estimate generally correlates with both the projectile point and ceramic assemblages. In addition, a radiocarbon sample was recovered from Post A, positioned 70 cm east of Post C. The resulting AMS analysis yielded a noncalibrated age of 870±28 B.P. (UGA 7215) and a calibrated age range of A.D. 1040 and 1220. These age estimates statistically overlap and generally correlate with both the projectile point and ceramic assemblages.

The structure entrance identified in the southeast portion of the structure by Runyan (1971) was tentatively observed, however, the degree of bioturbation in that portion of the pit house precluded further investigation. The contour of the pit house seemed to extend eastward, suggesting the structure was more symmetrical.

Feature 3 displayed attributes commonly assigned to pit houses in the Rio Grande valley, however, the morphology of the structure most approximates an ephemeral structure rather than a formalized pit house as encountered west of the Pecos River (Condon and Hermann 2009). In addition, TRC's findings were consistent with Nials, as cited in Haskell (1977) and supported Dr. Charles Frederick, project geomorphologist, in that the reddish brown (5YR 4/4) deposit associated with the pit houses is a natural occurring alluvium that emanates eastward from the basin margin and coalesces differentially along the lower margins of the playa. Therefore, Feature 3 was intrusive into an in situ horizon along the slopes of the knoll upon which the LCAS excavations were focused.

The cross section of Feature 3 revealed a shallow basin-shaped profile with a gradual-sloping west wall and a more abrupt east wall that ranged in depth from 85 cm to 98 cm below datum (datum is 15 cm above ground surface). This feature reached a maximum depth of 13 cm below the surface of the reddish brown alluvial soil horizon (Stratum III). The area surrounding the pit house consisted of lithic and ceramic scatters adjacent to the unit. Another previously investigated pit house (Feature 2) is 11 m southeast of Feature 3. Despite being collected for many years, this portion of the site still produced artifacts on the surface.

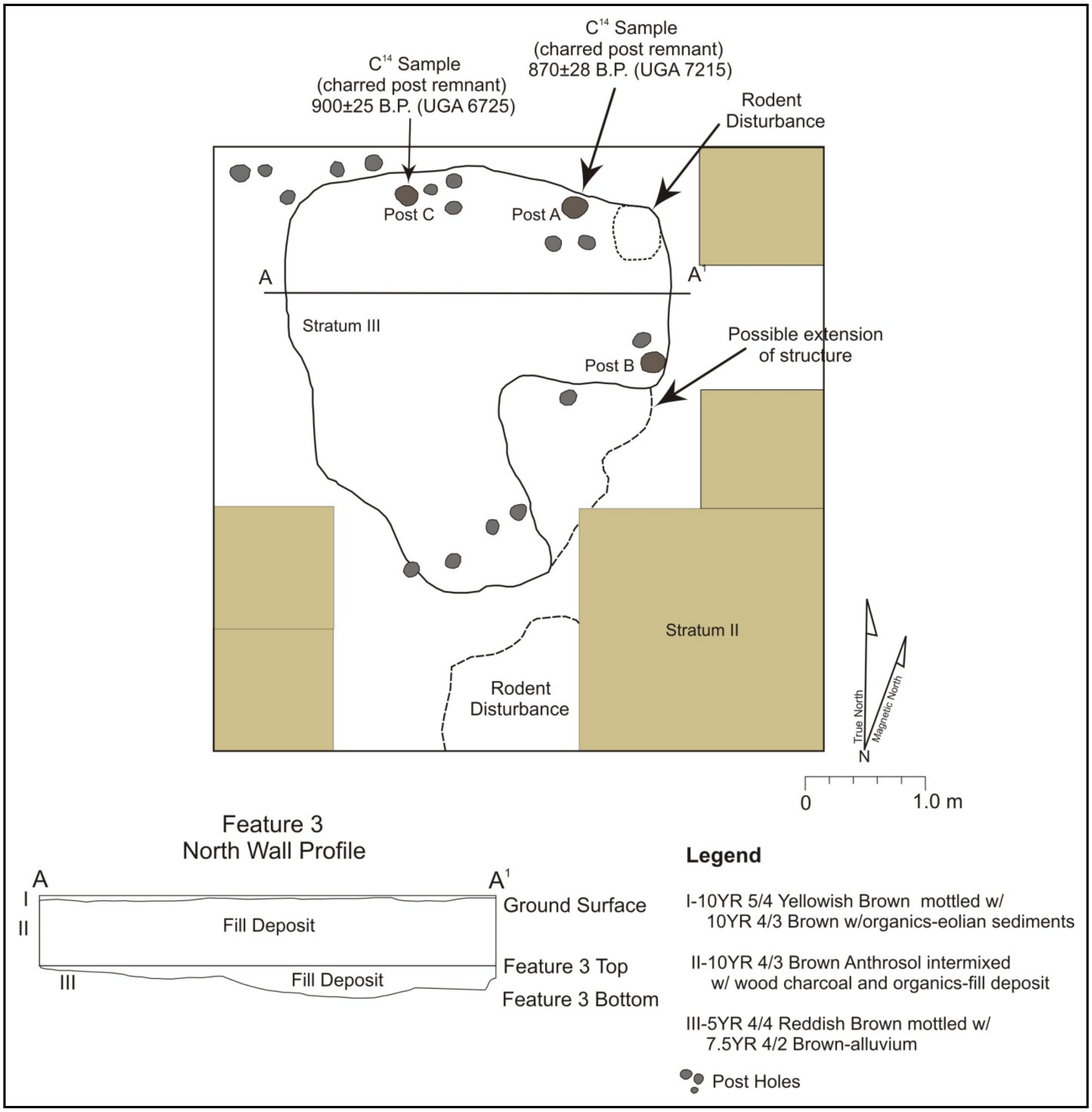

Figure 9.6 Feature 3 plan view and north wall cross section as defined by TRC Environmental

Figure 9.7 Charred post remnant from the northern margin of Feature 3 (TRC-Post C)

9.2.3.5 Test Unit 3 (Feature 6)

Test Unit 3, a 1 x 0.50-m unit in the northern portion of LA 5148, was placed over a feature exposed in the south wall of an arroyo cut bank. The arroyo paralleled an existing two-track pipeline access road that bisects the site in an east/west oriented direction. Each subunit within Test Unit 3 was excavated and collected for flotation. The overlying anthrosol deposit (Stratum I) consisted of a shallow, laminated matrix, clearly defined within the arroyo cutbank. Stratum I blankets Feature 6, suggesting the construction of the pit feature occurred prior to the development of the anthrosol. Stratum I ranged in depth from 16 cm below subdatum (subdatum is 13 cm above ground surface) to 49 cm below subdatum. The slope of the arroyo bank resulted in an uneven Stratum I deposit with the northern half of the unit deeper than the southern half. Stratum I terminated at the contact of either Feature 6 or the underlying Bk soil horizon (Stratum II-7.5YR 5/3, brown). Excavation of Test Unit 3 was terminated after exposing Feature 6.

9.2.3.6 Feature 6

Feature 6 was a clearly defined pit feature 37 cm north/south x 65 cm east/west and 40 cm in depth (Figure 9.8). Exposed in the south wall of a well-incised arroyo, the remaining cross section revealed a steep-sided pit that was intrusive into both Stratum II (7.5YR 5.6, brown, dry) and Stratum III (7.5YR 5/6, strong brown, dry) and terminating at the top of Stratum IV (7.5YR 3/3, dark brown with calcium carbonate, dry). Feature 6 also cross-cut two gravel lenses indicative of fluvial deposition. This basin-shaped feature tapered slightly downward with a flat bottom. The fill was a dark brown (7.5YR 3/2) with small pieces of wood charcoal observed throughout. After being drawn and photographed in cross section, the fill in Feature 6 was excavated using 10 cm arbitrary levels and collected for macrobotanical and radiocarbon analyses (Figure 9.9). The macrobotanical analysis identified indeterminate hardwood fragments. Wood charcoal fragments collected from the lower levels of Feature 6 were submitted to the University of Georgia for radiocarbon analysis. The resulting AMS assay yielded a conventional age of 1670±25 (UGAMS 6723) and a calibrated age estimate that ranged from A.D. 260 to 430. This age estimate correlates with Feature 2 and suggests a late Archaic occupation.

Figure 9.8 Photograph showing south wall profile of Feature 6 and associated soil profile

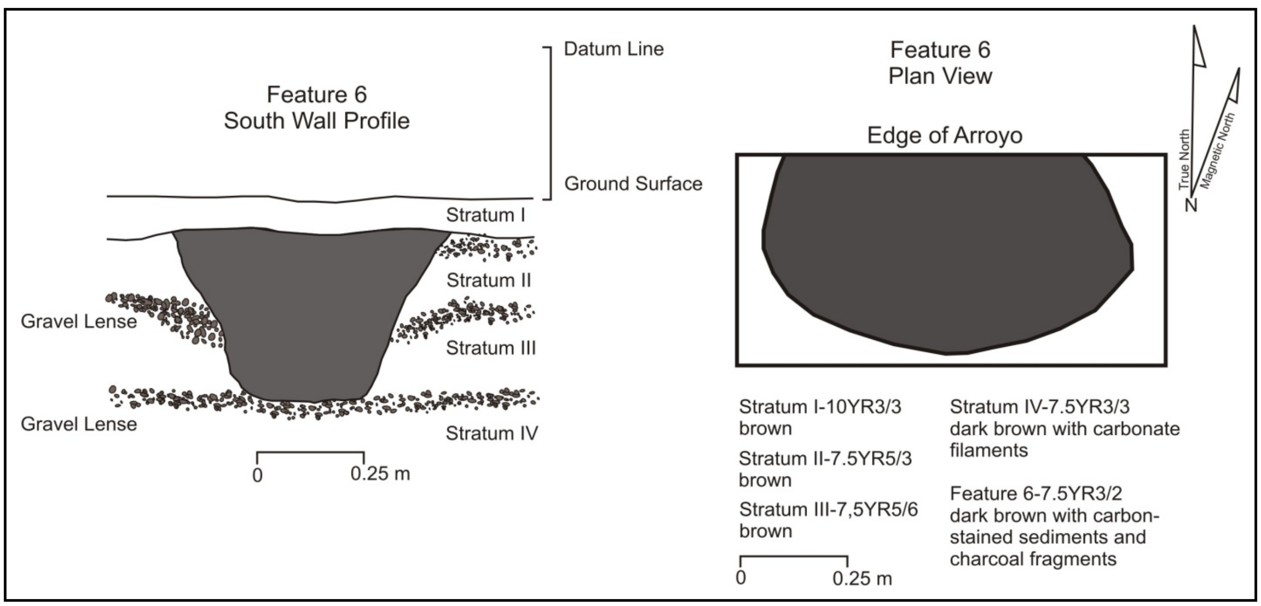

Figure 9.9 Test Unit 3-Feature 6 plan view and cross section profile of Feature 6

10.0 Analyses Methods

Peter C. Condon

Laboratory tasks included preparation and cataloguing of field material and the analysis of existing collections recovered from the Laguna Plata site. An outline of the analyses conducted is presented below followed by Table 10.1 showing the number of samples submitted. Existing collections consist of about 6,000 artifacts and include flaked-stone artifacts, sherds, ground stone, and faunal remains. Lithic analysis included identification of reduction technology, reduction trajectory, material type, and use-wear patterns. A sample of flaked and ground stone implements with potential of retaining organic residues were submitted for further analysis (Adams 1999, Hard et al. 1996, Quigg et al. 2001). Projectile point types were identified using established typologies. Sherds were sorted and identified according to type and temper. The Minimum Vessel Number (MVN) was assessed by color, thickness, temper, and, when possible, refits. These methods, used in conjunction with chronometric data, helped develop a more precise interpretation of ceramic trends through time (Abbott et al. 1996). A sample of sherds was selected for organic residue analysis. Proposed analyses include radiocarbon dating, macrobotanic, pollen, opal phytolith, starch grain, and fauna. Analytical procedures are presented below. Artifacts and other durable items not selected for special analysis (residue studies, chronometric dating, etc.) were washed and catalogued according to standards in the Southeast New Mexico Regional Research Design (SENMRRD) and entered into an ACCESS database table (Hogan 2006). All artifacts and original supporting documentation were transferred to TRC's Albuquerque facility in preparation of curation at the Museum of New Mexico in Santa Fe.

10.1 Lithics

10.1.1 Flaked-Stone Analysis

Flaked-stone studies focused on identifying cultural/temporal markers, subsistence related function, and activity diversity. TRC used four lithic attribute categories for debitage. The attributes included 1) size, 2) dorsal cortex, 3) platform remnant shape and type, and 4) raw material. Chipped stone was sorted into five sizes—<1 cm; 1 to <2 cm; 2 to <3 cm; 3 to <4 cm; and ≥4 cm (Ahler 1989; Andrefsky 1998). Dorsal cortex is commonly used as a proxy measure for identifying reduction stage and trajectory (Andrefsky 1998:118; Odell 2004:126). The percentage of dorsal cortex was estimated for each unbroken flake. Platform remnant analysis addressed two attribute categories: platform remnant type and platform remnant shape. Platform remnant type refers to the type of platform preparation, which provides evidence for identifying a core reduction sequence.

The Laguna Plata field work preceded (April 2010) the Permian Basin Mitigation Program Archaeological Data Comparability Workshop (ADCW) held in May, and the laboratory analysis preceded distribution of the workshop results (Railey 2010). However, most of the attributes incorporated into the final workshop coding spreadsheets and guidelines were used for the Laguna Plata analysis, and can be, for the most part, converted into the ADCW format. This also holds true for ground stone and ceramic analyses. The lithic analysis was done by Benjamin Bury and Peter Condon.

10.1.1.1 X-Ray Fluorescence Spectrometry

TRC submitted samples of obsidian artifacts for x-ray fluorescence spectrometry (XRF) analysis to identify the source of the obsidian. Samples were submitted to Dr. Steven Shackley at the University of California, Berkley's Geoarchaeological XRF Laboratory, Berkeley, California.

10.1.2 Ground Stone Analysis

Ground stone was assigned tool form (mano, metate, mortar, indeterminate, or unidentified fragment), number of functional surfaces, evidence of recycling such as use for heating, and material type (see also ADCW statement in paragraph two, section 10.1.1, this report). Ground stone implements were used to guide site activity interpretations in addition to acquiring organic residues pertinent to agriculture and subsistence. Ground stone analysis was done by Ben Bury and Peter Condon.

10.2 Ceramic Analysis

Ceramic analysis addressed chronological, technological, and regional interaction topics. Attributes included stylistic type, vessel form, vessel portion, and weight. Rim sherd analysis included orifice diameter and rim profile. Miller (1990) noted that small and eroded El Paso brownware sherds are difficult to identify by type. Therefore, sherds less that 3 cm in diameter were not analyzed by TRC; however, a sample was provided to Regge Wiseman for further analysis. The 3-cm diameter size was followed due to the analytical limitations and less likelihood of gleaning meaningful information from the small sherds, in addition to the BLM having approved this approach in TRC's proposal for testing and surveying the Laguna Plata site (TRC 2010:12) (see also ADCW statement in paragraph two, section 10.1.1, this report). Petrographic analysis and Instrumental Neutron Activation Analysis (INAA) provided information about the sudden influx of pottery types at A.D. 1250 to 1300 and the equally rapid decline as it relates to trade networks. Identifying clay, temper, and other manufacturing material sources contributed to the ceramic technology, regional variability, and possible mobility and trade networks. In addition, spatial and temporal analysis of the distribution of ceramic types helped determine the occupation and abandonment sequences and elucidate intra-site settlement patterns and social organization.

10.2.1 Instrumental Neutron Activation Analysis (INAA)

INAA is an analytical technique used for qualitative and quantitative multi-element analysis of trace elements in pottery. This supplemented the existing INAA study being funded by the Permian Basin Mitigation Program grant awarded to TRC in 2010. Samples included local brownware variants, Chupadero Black-on-white, and El Paso Brown sherds. Results are be compared to existing data sets available at the University of Missouri University Research Reactor (MURR) and at the Fort Bliss Directorate of Public Works, Environmental Division, Conservation Branch, El Paso, Texas. Samples were submitted to Michael Glasscock of MURR.

10.3 Faunal Analysis

Faunal analysis focused on levels of importance concerning animal resource exploitation, discard patterns, the effect of environmental setting on preservation, and the length and intensity of occupation. Interpretations focused on elucidating cultural behaviors (e.g., subsistence patterns, hunting, butchering, bone technology, ceremonialism), and environmental reconstruction. The recognition of subsistence patterns includes seasonality when discernable. Refits were made and fresh breaks mended whenever possible, reducing the total number of specimens. Variables recorded for each specimen included the determination of the lowest possible taxon (e.g., order, family, genus,, species) or animal size (e.g., small bird, large mammal), element, side, portion, condition (e.g., burned, gnawed, presence of butchering marks, worked). Faunal analysis also included a determination of the minimum number of individuals (MNI), as well as the number of identified specimens present (NISP).

Faunal analysis also targeted changes in subsistence pertinent to agriculture and the hunting of bison. For example, Akins (2002:155) suggests sedentary groups tend to hunt a variety of species in the immediate vicinity of a settlement and the taxa diversity reflects the richness of the local environment. Hunting at a distance from the settlement tends to be more selective (Akins 2002:156). Analysis attempts to discern these patterns in the assemblage. In addition, do bison remains indicate nearby or distance hunting, i.e., do the remains represent both low and high meat-value elements or are they mainly high value elements? Do the bison elements reflect intensive processing for marrow and grease extraction? Is seasonality represented by the bison or other artiodactyl remains (e.g., deer, pronghorn, mountain sheep)? Is the assemblage age selective (e.g., young versus mature, mature versus old). Are fetal/neo-natal individuals present? Are butchering patterns determinable? Which taxa were dietary staples, and did they change through time? Faunal analysis was conducted by Marie E. Brown and Kenneth L. Brown.

10.4 Geomorphology

The stratigraphic sequencing and depositional history, including an assessment of playa dynamics, was conducted by Charles Frederick. Geoarchaeological analysis included micromorphology and stable isotope analysis of sediments, radiocarbon dating of soil units, and climatic reconstruction based on diatom analysis and pedogenic organic/carbonate development of soils.

10.4.1 Stable-Isotope Analysis

Stable isotope analysis can provide a form of proxy measure of past precipitation and related temperature variations in identified faunal remains, soils and sediments. Common isotopes include $_{13}C$, $_{18}O$, and $_{15}N$. Variability in isotope composition, in particular $_{13}C$ values, reflect climate-driven shifts in the abundance in C_3 and C_4 plant species, and provides information on the paleodiet. Stable isotope samples were collected from pedogenic carbonates occurring in soil units exposed during excavations. Stable isotope analysis was conducted at the Colorado Plateau Stable Isotope Laboratory, Northern Arizona University, Flagstaff, Arizona.

10.4.2 Diatom Analysis

Diatoms are algae whose cellular contents are enclosed between two valves of silica that is preserved when the organism dies. Diatoms occur in abundance from extant and fossil lake or playa deposits. In terms of importance, diatoms of different taxa have different temperature, salinity, water depth, water clarity, and lake/playa nutritional content tolerances and respond quickly to changes in these factors. Diatom analysis was conducted by Barbara Winsborough, Leander, Texas, in conjunction with Charles Frederick.

10.5 Macrobotanical Analysis

Sediments were collected from excavated contexts that might yield prehistoric plant remains. Samples were processed in the laboratory using the Flote-Tech Flotation System of R. J. Dausman Technical Services, Inc. Standardized 10-liter samples were processed (Hunter and Gassner 1998). Interpretations are important for the two primary foci of the botanical analysis: the elucidation of cultural behaviors (e.g., subsistence patterns, gathering, planting and harvesting, ceremonialism), and environmental reconstruction. The recognition of subsistence patterns included seasonality data, if available. Identification of taxa that may have been encouraged to grow in the site proximity (e.g., rye, grasses; maize) may lend important information about the adoption of early horticulture and agriculture in the region. Evidence for the abandonment of agriculture in the mid–late fourteenth century is examined in addition to how subsistence strategies changed in response to the increased abundance of bison beginning in the late thirteenth century. Botanical remains were analyzed by Richard Holloway of Quaternary Services, Flagstaff, Arizona.

10.6 Pollen Analysis

The extremely sandy environment and probable thermal association of soil stains reduced the likelihood for the preservation of pollen. An off-site sample was collected for control purposes. Richard Holloway of

Quaternary Research conducted the pollen analysis. The results are discussed in Chapter 18 and presented in Appendix B.

10.7 Starch Grain Analysis

Starch analysis was conducted on selected ground stone and pottery sherds based on context and probability for yielding results. Starch signatures of various plant species can be distinguished from one another by using a combination of light and chemical tests. Starch characteristics, individually defined by shape, intensity, color, and absorption, can be used in place of, or in combination with, other features of the plant to facilitate the identification of plant remains (McNair 1930). TRC submitted samples to Linda Perry of the Archaeobiology Program, Smithsonian National Museum of Natural History.

10.8 Organic Residue Analysis

Ground stone surfaces and sherds were selected for extracting proteins and fatty residues. Previous research demonstrates organic residue samples can be extracted from burned rocks (Malainey and Malisza 2003; Quigg et al. 2001). This type of investigation assumes importance when environmental conditions are not conducive to the preservation of primary organic data, such as macrobotanical and faunal remains. This included a limited number of samples for Fourier Transform Infrared Spectroscopy (FTIR) analysis (Quigg personal communication, 2010). Samples were submitted to Linda Scott-Cummings of PaleoResearch Institute, Golden, Colorado.

10.9 Radiocarbon Dating

Radiocarbon assays of organic remains, charred seeds and wood charcoal, will serve as the primary basis for evaluating site chronology. Addressing many of the research questions depends on the accurate placement of cultural contexts within a temporal framework. Radiocarbon samples were submitted to the Center for Applied Isotope Studies at the University of Georgia, Athens. All wood and seeds were identified prior to submittal. Dating annuals was preferred over perennials or wood.

Table 10.1 Number of samples submitted for analysis, LCAS and TRC

Laboratory Analyses Performed	Number of Samples Submitted/Analyzed
LCAS	
Lithics	**1,351**
Flaked Stone	1,334
X-ray Fluorescence Spectrometry	0
Ground Stone	17
Ceramic	**7602**
Instrumental Neutron Activation Analysis (INAA)	0
Faunal	**1810**
Geomorphology	0
Stable Isotope	0
Diatom	0
Macrobotanical	0
Pollen	0
Starch Grain	0
Organic Residue	0
Radiocarbon Dating	0

Laboratory Analyses Performed	Number of Samples Submitted/Analyzed
Laboratory Analyses Performed	**Number of Samples Submitted**
TRC	
Lithics	**32**
Flaked Stone	30
X-ray Fluorescence Spectrometry	6
Ground Stone	2
Ceramic	**24**
Instrumental Neutron Activation Analysis (INAA)	16
Faunal	53
Geomorphology	
Stable Isotope	20
Diatom	8
Macrobotanical *(4 flotation, 1 macro)*	5
Pollen	5
Starch Grain *(4 ceramic, 3 ground stone)*	7
Organic Residue *(3 ground stone, 2 flaked stone, 2 ceramic)*	7
Radiocarbon Dating	9

10.10 Curation

All cultural material, field notes, analysis forms, and documents generated during the course of the project were processed in accordance with 36 CFR 79, the Curation of Federally Owned and Administrated Archaeological Collections. The collections were processed in accordance with the current policies and standards defined by the Museum of New Mexico, Santa Fe, where they will be curated.

11.0 Geomorphology

Charles D. Frederick

11.1 Introduction

Geoarchaeological investigations at the Laguna Plata site were performed in April 2010. Laguna Plata is on the Querecho Plains at the west end of an east-west trending depression that Alexander and Clebsch (1961) named the Laguna Valley. The Laguna valley is between the Mescalero Ridge and the Grama Ridge. Laguna Plata is a salt lake basin that genetically is similar to more than 30 similar basins on the Llano Estacado that are referred to as salt lakes, alkaline lakes, pluvial lakes or *salinas* in the Quaternary geological literature. The *salinas*, unlike the playas, which number in the thousands, are deep basins that often support perennial saline water bodies and are usually much larger than the playas. The fact that Laguna Plata is outside the present boundaries of the Llano Estacado is merely an artifact of erosion that occurred in the Upper Tertiary and Quaternary in association with formation of the Pecos River valley. While there is a large literature on the geology of playas on the Llano Estacado (cf. Holliday et al. 1996, 2008; Hovorka 1995; Ostercamp and Wood 1987; Smith 2003;) there exist few detailed studies of the salinas and their associated late Quaternary deposits (e.g. Quigg et al. 1993; Reeves 1991, 1976; Rich et al. 1999; Wood et al. 2002) (Figure 11.1).

In the broader geomorphological literature, ephemeral, closed salt lake basins such as this are often referred to as pans (cf. Goudie and Wells 1995). The primary formation of these large salt lake basins in this region is widely accepted to be karstic, and associated with dissolution of salt deposits (gypsum, anhydrite, halite and dolomite) at depth within the Permian age Rustler and Salado formations, which eventually causes collapse of the overlying strata and the formation of a subsidence depression (Lambert 1983; Reeves 1991). However, in the literature there has been a protracted debate whether structural subsidence or aeolian deflation was the dominant formation process. Reeves (1991) notes that many, but not all, of the salinas exhibit dissolution of bedded salt beneath the lake and it is not clear whether the lake caused dissolution of the salt or the dissolution of the salt created the structural depression and the lake. Reeves (1991:485) observed there is a prominent dissolution area beneath Laguna Plata with approximately 76 m of salt missing but that the adjacent basins of Tonto and Gatuna do not exhibit similar solutional depressions.

Although the karsitic origins of “the Laguna Plata subsidence area”, as this area has been described by Reeves (as cited in Howard 1987), seems well established, evidence of aeolian deflation is often extensive in such pans, but there seems to be little recognition of this with respect to the Laguna Plata basin in the past. Pans are typically fringed by arcuate (in plan form) dunes called lunettes or clay dunes that occur on the down wind or lee side of the pan (Hills 1940; Bowler 1973; Bowler 1983; Goudie and Wells 1995; Stephens and Crocker 1946). Unlike normal sand dunes that migrate downwind away from the sediment source, lunettes migrate upwind toward the sediment source because they are composed of sticky sand sized aggregates of mud that are deflated from the desiccated lakebed and blown to the lakeshore. These aggregates weld together once wet, and create relatively stable, dunes that demarcate the shoreline of the pan/salt lake when they were formed. Although prone to erosion by water, once stabilized, lunettes are, unlike sand dunes, relatively unlikely to become re-mobilized by wind. This is in part due to the fact that the sand sized mud aggregates are sticky, and their initial formation prior to aeolian entrainment is closely linked to salt crystal growth (usually gypsum) on the lakebed.

11 x 17 map

Figure 11.1 Laguna Plata section map

Lunettes are common around the smaller playas on the Southern High Plains (e.g. Frederick 1994, 1998; Holliday 1997a) but these playas generally only have a single lunette fringing the eastern side of the pan. The salinas, on the other hand, typically have multiple generations of clay dunes fringing the eastern side of the lake basin (cf. Melton 1940; Quigg et al 1993; Reeves 1965). Reeves (1965) and Melton (1940) identify three series of nested clay dunes around the larger alkaline lakes on the Southern High Plains, with the outermost dune demarcating the maximum extent of the lake, and with the dunes closer to the modern lake reflecting progressive desiccation of the pan through the Holocene. Although absolute dates are few, it seems the outermost dunes are generally of fill of late glacial age or older, whereas the dunes closest to the lakes are of Holocene age and generally contain buried archaeological sites. Quigg et al. (1993) examined the Red Lake basin, adjacent to Sulphur Springs Draw in Martin County, Texas, and they identified a suite of three clay dunes on the east side of Red Lake. A limited number of trenches were dug to examine the deposits and they showed that the oldest and largest dune was in excess of 10,000 years old, composed of reworked light gray Tahoka Formation sediment and draped with a thin aeolian sand sheet. Conversely, the youngest clay dune was thought to be of Holocene age, located immediately adjacent to the lake and was not buried by a sand sheet. Unlike the two older dunes, the deposits of the youngest dune were a strong brown-red color given that it was formed from deflated Permian red beds after all of the late Pleistocene Tahoka Formation had been deflated from the lake bed. The sand sheet in this basin was subsequently examined by Holliday (2001:103–104) and again dated to the Holocene.

11.2 Field Methods

Several different methods were employed during the work in and near the Laguna Plata site. The western Lakeshore Plain was initially walked in order to evaluate the geomorphology and identify where trenches might be situated. After this a series of cores were collected from the knoll immediately around the former excavations by means of an Eijkelkamp percussion corer. The cores employed an open sided gouge and the deposits were cored to a depth of 2 m, and subsequently photographed and described. Following this, a backhoe was used to excavate eight trenches, five of which were on the western lakeshore plain and three were on the south side of the lake. Trench exposures were cleaned with a trowel and knife, and then photographed and described using methods in general accordance with Schoeneberger et al (2002). Field exposures were evaluated using a soils-geomorphology approach following Birkeland (1999). Specific reference to the development of soil calcic soil horizons follows the nomenclature described by Gile et al. (1981) and Holliday and Jacobs (1995).

11.3 Laboratory Methods

A small number of bulk soil/sediment samples (n=42) were collected in the field for additional analysis in the laboratory, and six oriented samples were collected for soil micromorphology. Bulk samples were characterized for the texture, magnetic susceptibility, and loss-on-ignition as a proxy for organic carbon, and a subset of samples were submitted to Colorado Plateau Stable Isotope Laboratory at Northern Arizona University for determination of the stable carbon isotopic composition. The specific methods employed are described in detail below.

11.3.1 Particle Size Analysis

The particle size distribution (or texture) is a fundamental property of any sediment or soil and is useful in identifying sedimentary depositional environments of ancient sedimentary deposits. When dealing with soils formed within sedimentary deposits, the texture informs on the depositional process that deposited the sediment and post-depositional alteration that has affected the sediment since deposition ended (e.g. pedogenesis or soil formation).

The texture of each sample was determined on a Beckman-Coulter LS 13-320 multi-wavelength laser sizer. Samples were first split using a micropaleontological splitter (a small riffle splitter), and then placed in a beaker on a hot plate to which concentrated (30%) hydrogen peroxide was added in to remove organic matter. Upon addition of the hydrogen peroxide the samples effervesced and were left on the hot plate until the reaction had ceased, at which point they were removed from the hot plate, cooled and then measured on the LS-13-320. The results of these analyses are presented as percentages of sand, silt and clay, as well as in the form of descriptive statistics advocated by R. L. Folk in his seminal work *Petrology of Sedimentary Rocks* (1968). The descriptive statistics are presented in phi units (a negative log base 2 conversion of millimeters). In the phi system, sands exhibit phi values between 0 and 4, silts between 4 and 9, and clay > 9 phi. The USDA soil texture class for each sample was determined using the Soil Texture calculator provided by the NRCS website (NRCS 2010).

11.3.2 Organic matter (LOI)

Organic matter was estimated by the loss-on-ignition method, which can provide a reasonable proxy for organic carbon content. LOI can also overestimate organic carbon where lattice expandable clays and other minerals than incorporate water in their structure (e.g. gypsum) are present.

This method used here involved weighing a sample into a porcelain crucible, drying in an oven at 150 ˚C overnight to drive off all interstitial and structural water, reweighing, and then combusting in a muffle furnace at 450˚C for two hours. The resulting weight loss upon ignition is then considered to be an approximation of organic matter. Given the relatively high percentage weight loss observed in some samples and the location of these samples within the stratigraphic sequences suggests some minerals must have retained structural water even after drying at 450˚C.

11.3.3 Stable Carbon Isotopes

A select suite of soil/sediment samples was submitted to the Colorado Plateau Stable Isotope Laboratory at Northern Arizona University for determination of the stable carbon composition of the soil organic matter. These samples had calcium carbonate removed and were then combusted and the isotopic composition of the organic matter determined on Thermo Electron gas isotope-ratio mass spectrometer.

The results of this work are most usefully interpreted in terms of change in values through time (see Figure 11.2), but only some of the samples can be confidently evaluated in this manner owing to the number and stratigraphic position of radiocarbon ages obtained. The most complete record is for the late Holocene, which comprises samples collected from the coppice dune in Trench 5, the Late Holocene alluvium in Trench 1, and the modern alluvium exposed in Trench 3. Based on Hall's study (REFS) the coppice dunes can be assumed to be less than 100 years old, and the ages of the sediments sampled from Trench 1 can be calculated using the radiocarbon ages derived from that trench and assuming a linear sedimentation rate (see Table 11.1, below).

Table 11.1 Isotope Age

Sample	$\delta^{13}C$	Age	Derivation of Age
	(‰ PDB)	(years BP)	
Trench 5, sample 1	-21.26	25	Assumed
Trench 5, sample 2	-20.50	70	Assumed
Trench 1, sample 1	-19.97	89	Calculated
Trench 1, sample 2a	-17.67	230	Calculated
Trench 1, sample 2ab	-18.52	306	Calculated
Trench 1, sample 2b	-20.86	408	Calculated
Trench 1, sample 3	-17.13	510	Radiocarbon; 510±25, UGAMS-5148
Trench 1, sample 4	-19.10	619	Calculated

Sample	$\delta^{13}C$	Age	Derivation of Age
	(‰ PDB)	(years BP)	
Trench 1, sample 5	-18.43	1177	Calculated
Trench 1, sample 6	-21.20	1424	Calculated
Trench 1, sample 7	-18.00	1641	Calculated
Trench 1, sample 8	-19.25	1780	Calculated
Trench 1, sample 9	-21.27	2090	Calculated
Trench 1, sample 10	-18.85	2446	Calculated
Trench 1, sample 11	-19.71	2554	Calculated
Trench 1, sample 12	-22.10	2880	Calculated
Trench 1, sample 13	-23.47	3808	Calculated
Trench 1, sample 14	-23.35	4690	Radiocarbon; 4690±25, UGAMS-7210
Trench 8, sample	-11.6	3660	Radiocarbon; 3660±25, UGAMS-7212
Trench 8, sample	-13.1	3470	Radiocarbon; 3470±26, UGAMS-7213

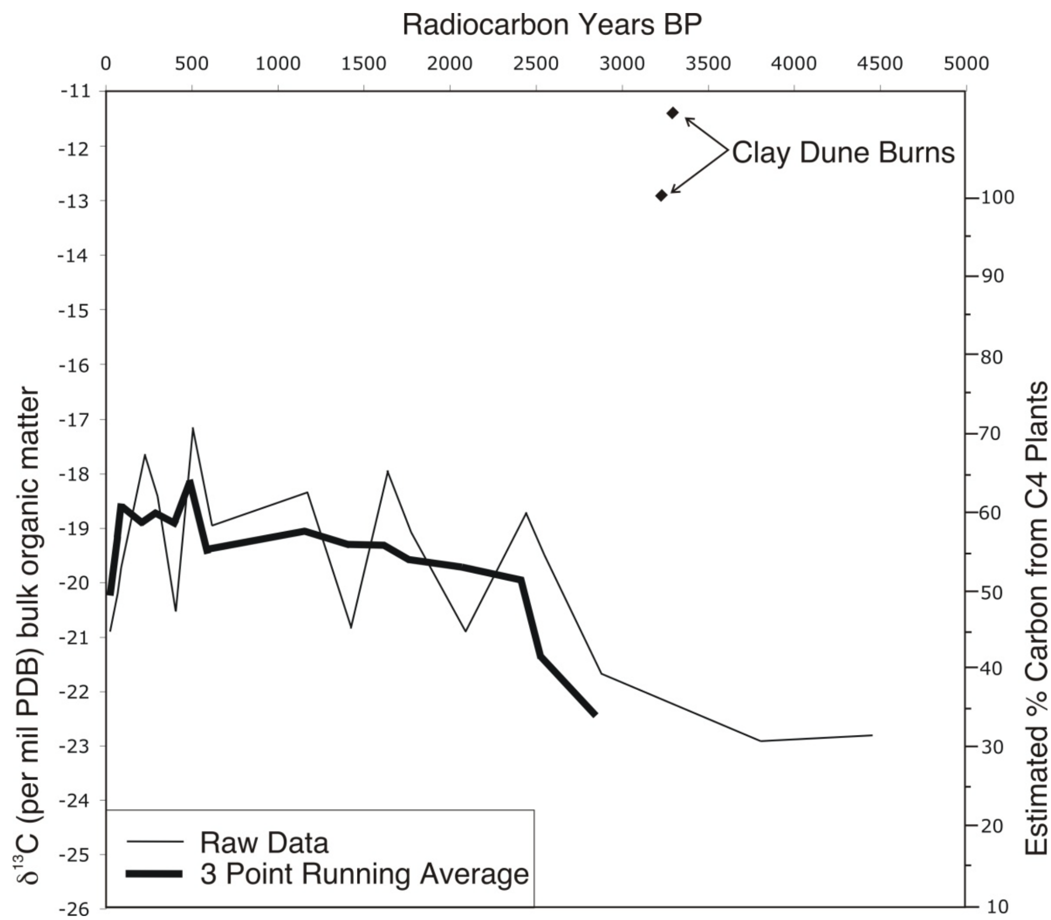

Figure 11.2 Laguna Plata Isotopes

The data indicates that there has been significant short-term variation in $\delta^{13}C$ throughout the late Holocene but the three-point running average indicates that a significant long-term trend appears to be present. Prior to 2500 radiocarbon years BP (or RCYBP) C_3 plants contributed a significantly greater proportion of the carbon to the alluvial sediments (something around 60-70%) and that between 2500 and 500 years BP the values were relatively stable (oscillating between -18 ‰ and -21 ‰ or approximately 45% and 65% C_4 derived carbon). The greatest C_4 contribution on this record occurred around 500 RCYBP when the $\delta^{13}C$ of the alluvium suggests that about 70% of the organic carbon was being contributed by C_4 plants. The values remained elevated until the last century when the proportion of soil organic carbon derived fromC_3 vegetation began to increase. The modern sediment in Trench 3 yielded $\delta^{13}C$ values of -19.33 ‰, which indicates that slightly less than 40% of the organic carbon in the alluvium was derived from C_3 plants, presumably the mesquite which comprises the coppice dunes. The eolian sand and soil formed in the coppice dune sampled by Trench 5 yielded $\delta^{13}C$ values of –21.26 ‰ and -20.50 ‰, and the value obtained from the A-horizon, which appears to have formed primarily from mesquite leaf litter, seems a bit low for such a soil.

The limited stable carbon isotope results indicate that the composition of the vegetation within the basin has changed through time, and that additional work on the carbon isotopic composition of soil/sediment organic matter from dated sedimentary sequences may yield a long-term proxy record of vegetation change. The complete results of the stable carbon isotopic analysis are listed on Table LP Lab Data ver2.xls in Appendix D.

11.3.4 Magnetic Susceptibility

Magnetic susceptibility is a general measure of the degree to which a sample may be magnetized, and provides basic information on the magnetic mineralogy of the sample, which may vary owing to a variety of factors, such as depositional processes, soil development, and human occupation. The general application of magnetic susceptibility in archaeological studies has been discussed in detail by Dalan (2008) and Dalan and Bannerjee (1998).

The magnetic susceptibility samples were first dried, weighed, and then the low frequency (470 Hz) and high frequency (4700 Hz) magnetic susceptibility (kappa) was measured in SI units on the 0.1 setting on a Bartington MS2 meter and an MS2b sensor (see Dearing 1999a). The mass corrected magnetic susceptibility (chi, or χ_{lf}) and coefficient of frequency dependency (χ_{fd}) were then calculated. The coefficient of frequency dependency (χ_{fd}), is the percent difference in magnetic susceptibility measured at low and high frequencies (calculated as: $\chi_{fd} = (\chi_{lf} - \chi_{hf})/\chi_{lf})*100$). Elevated values of χ_{fd} (ca. >10%; Gale and Hoare 1991:213) are indicative of increased concentrations of fine-grained ferrimagnetic minerals, most often maghemite, in top soils (Dearing et al 1996; Dearing 1999b), but none of the samples measured exhibited elevated values of χ_{fd}. The χ_{lf} magnetic susceptibility values are presented in Table 11.2 and are reported in SI units ($10^{-8}m^3kg^{-1}$).

11.3.5 Soil Micromorphology

Samples collected for micromorphology consisted of small oriented blocks carved from the excavation walls that were then wrapped in toilet tissue and masking tape, and subsequently dried, embedded in polyester resin under a vacuum, and then slabbed on a rock saw. Features of interest were trimmed and submitted to National Petrographic in Houston, Texas, for thin section manufacture. Six 2 x 3-inch petrographic slides were made from sediments collected from the following proveniences:

1) Trench 1 (172–188 cm; Zones 9, 10 and 11),
2) Trench 4 (25–45 cm, Zones 3–4; 60-75 cm, Zones 5–6–7; and 92–100 cm, Zone 8),
3) Trench 5(58–68, Zone 4); and
4) Trench 7 (2–18 cm, Zone 1–2).

Table 11.2 Lab data generated for selected deposits exposed by trenching in the vicinity of the Laguna Plata Site

Sample	Depth	Mean	Median	Sorting	Skewness	Kurtosis	Sand	Silt	Clay	Texture Class	Xlf	LOI
Trench 1	(cm)	(phi)	(phi)	(phi)	(phi)	(phi)	(%)	(%)	(%)		$10^{-8}m^3kg^{-1}$	(%)
LagPlata1-1	17.5	3.14	2.78	1.53	0.50	1.75	79.8	18.09	2.11	Loamy Sand	9.8	2.6
LagPlata1-2a	45	3.57	3.12	1.57	0.52	1.36	72.3	25.36	2.34	Sandy Loam	7.2	2.3
LagPlata1-2ab	60	3.53	3.00	1.90	0.46	1.17	69.2	28.52	2.28	Sandy Loam	5.5	3.5
LagPlata1-2b	80	3.62	3.24	1.71	0.42	1.19	66.8	30.79	2.41	Sandy Loam	6.5	2.8
LagPlata1-3	102	4.43	4.12	2.00	0.28	0.83	48.4	48.31	3.29	Sandy Loam	6.8	2.9
LagPlata1-4	122	2.85	2.61	1.29	0.48	1.84	83.9	14.49	1.61	Loamy Sand	4.9	0.9
LagPlata1-5	138	3.90	3.54	1.91	0.33	0.88	55.8	41.71	2.49	Sandy Loam	10.1	1.3
LagPlata1-6	146	3.22	2.67	1.65	0.56	1.46	77.1	20.98	1.92	Loamy Sand	5.2	3.9
LagPlata1-7	153	4.51	4.59	2.07	0.04	0.82	41.7	55.16	3.14	Silt Loam	6.2	6.8
LagPlata1-8	157.5	3.97	3.74	1.85	0.26	0.93	54.4	43.23	2.37	Sandy Loam	5.2	3.7
LagPlata1-9	167.5	3.24	2.65	1.69	0.55	1.09	73.3	24.86	1.84	Loamy Sand	4.3	2.7
LagPlata1-10	179	4.68	4.73	1.90	0.05	1.13	32.7	63.79	3.51	Silt Loam	7.2	4.3
LagPlata1-11	182.5	4.41	4.35	1.88	0.12	0.98	42.7	54.51	2.79	Silt Loam	6.2	4.4
LagPlata1-12	193	4.38	4.17	2.15	0.20	0.79	48.3	48.37	3.33	Sandy Loam	6.4	2.1
LagPlata1-13	223	3.04	2.71	1.46	0.42	1.19	76.9	21.71	1.39	Loamy Sand	8.2	2.8
LagPlata1-14	244	2.95	2.77	1.29	0.31	1.28	81	17.92	1.08	Loamy Sand	8.8	2.1
Trench 3												
Sample	**Depth**	**Mean:**	**Median:**	**Sorting**	**Skewness:**	**Kurtosis:**	**Sand (%)**	**Silt (%)**	**Clay(%)**	**Texture Class**	**Xlf**	**LOI**
LagPlata3-1	10	4.48	4.08	2.10	0.33	0.91	48.3	47.47	4.23	Sandy Loam	19.3	2.3
LagPlata3-2	30	4.47	3.51	2.56	0.53	0.72	54.7	38.37	6.93	Sandy Loam	13.6	1.3
LagPlata3-3	50	4.30	3.57	2.32	0.46	0.72	53.4	42.01	4.59	Sandy Loam	11.3	1.3
Trench 4												
Sample	**Depth**	**Mean:**	**Median:**	**Sorting**	**Skewness:**	**Kurtosis:**	**Sand (%)**	**Silt (%)**	**Clay(%)**	**Texture Class**	**Xlf**	**LOI**
LagPlata4-1	4.5	3.67	2.93	1.95	0.61	1.40	72.4	24.32	3.28	Sandy Loam	25.4	1.7
LagPlata4-2	11.5	3.87	3.37	1.89	0.47	1.23	64.5	31.91	3.59	Sandy Loam	32.6	1.1
LagPlata4-3	21	3.67	3.39	1.67	0.37	1.23	64.9	32.59	2.51	Sandy Loam	28.8	2.3
LagPlata4-4	37.5	3.91	3.35	1.87	0.45	0.90	60.8	37.16	2.04	Sandy Loam	14.7	1.6

Sample	Depth	Mean:	Median:	Sorting	Skewness:	Kurtosis:	Sand (%)	Silt (%)	Clay(%)	Texture Class	Xlf	LOI
LagPlata4-5	52.5	4.05	3.23	2.12	0.53	0.73	59.4	37.94	2.66	Sandy Loam	12.6	1.6
LagPlata4-6	63	3.55	2.63	2.13	0.59	0.80	65.7	31.97	2.33	Sandy Loam	7.4	3.6
LagPlata4-7	68	3.32	2.47	2.23	0.52	0.89	68.1	29.73	2.17	Sandy Loam	23.1	2.9
LagPlata4-8	81	3.71	2.93	1.95	0.55	0.76	63.5	34.47	2.03	Sandy Loam	7.4	2.5
LagPlata4-9	102	2.47	2.33	1.04	0.33	1.60	89.8	9.35	0.85	Sand	6.7	2.1
LagPlata4-10	117	3.85	3.53	1.94	0.29	1.09	59.2	37.84	2.96	Sandy Loam	5.3	3.7
LagPlata4-11	130	4.20	3.72	2.04	0.39	1.03	54.7	41.13	4.17	Sandy Loam	4.2	3.2
Trench 5												
Sample	**Depth**	**Mean:**	**Median:**	**Sorting**	**Skewness:**	**Kurtosis:**	**Sand (%)**	**Silt (%)**	**Clay(%)**	**Texture Class**	**Xlf**	**LOI**
LagPlata5-1	9	3.09	2.94	1.27	0.45	1.97	83	14.68	2.32	Loamy Sand	25.3	1.6
LagPlata5-2	30	3.07	2.92	1.33	0.46	2.05	83.2	14.18	2.62	Loamy Sand	25.6	1.0
LagPlata5-3	47	3.23	2.94	1.56	0.47	1.74	77.7	19.44	2.86	Loamy Sand	29.4	1.2
LagPlata5-4	60	3.72	3.30	1.77	0.41	1.07	64.4	33.62	1.98	Sandy Loam	23.3	1.9
LagPlata5-5	80	4.09	3.14	2.20	0.58	0.72	63.3	33.45	3.25	Sandy Loam	16.3	1.4
LagPlata5-6	98	3.61	2.81	1.91	0.62	1.49	75.2	22.56	2.24	Loamy Sand	14.7	1.0
LagPlata5-7	121	3.03	2.68	1.57	0.42	1.28	77.2	20.95	1.85	Loamy Sand	10.3	1.9
Test Unit 2												
Sample	**Depth**	**Mean:**	**Median:**	**Sorting**	**Skewness:**	**Kurtosis:**	**Sand (%)**	**Silt (%)**	**Clay(%)**	**Texture Class**	**Xlf**	**LOI**
Strat I	4	3.11	2.81	1.50	0.56	2.12	81.2	15.87	2.93	Loamy Sand		
Strat II	20.5	3.71	2.87	2.04	0.63	1.33	72.5	24.22	3.28	Sandy Loam		
Strat III	42.5	3.36	2.68	1.86	0.61	1.69	77.1	20.29	2.61	Loamy Sand		
Strat IV	66	2.66	2.46	1.30	0.41	1.77	85.6	13.08	1.32	Loamy Sand		
Strat V	86	2.57	2.48	0.92	0.26	1.50	91.7	7.19	1.11	Sand		

The thin sections were examined at a range of magnifications. Low magnification examination was performed with the aid of a flat bed scanner and the slides were scanned at 1200 dpi using transmitted light (slide mode). Full page color laser prints of the slides were used to perform the first pass assessment of each slide. Areas of interest were then identified and examined with a Leica S8 APO binocular microscope fitted with transmitted light base and polarizing filters. Higher magnification examination employed a Leica DMEP polarizing light microscope. Descriptions of the soils follow methods suggested in Stoops (2003) and Bullock et al. (1985).

11.4 Summary of Field Observations

Results of previous site investigations were summarized earlier and will not be repeated here. Instead, the following describes the results of the geoarchaeological field investigations performed for this study, and then summarizes those results in terms of their implications for the larger archaeological landscape. The fieldwork was designed to examine several different landscape elements in the vicinity of the Laguna Plata site in order to understand how dynamic the environment has been in the recent past, and the implications this geomorphic activity holds for archaeological visibility and site preservation. Two specific landscape areas were examined: 1) the Western Lakeshore Plain and 2) the Southern Clay Dunes and Ponds. The location of the two field study areas are shown in Figure 11.3.

11.4.1 The Western Lakeshore Plain

The area around Laguna Plata has been mapped geologically by Hunt (1977) and the New Mexico Bureau of Mines and Mineral Resources (2003) but neither of these was mapped at a scale capable of reflecting the true complexity of the landscape. The most detailed mapping of the area is the soil survey where Turner et al. (1974) have mapped the soils in proximity to Laguna Plata, but the geologic complexity of the landscape is greater than could be captured by the scale of the mapping they employed (1:31,600). For instance, they classified the land immediately adjacent to the lake as "badland" and go on to define this as terrain "*made up of barren areas of soft, water laid and wind-laid sediment…Many recent gullies cut the slopes leaving a rough and denuded landscape*" (Turner et al. 1974:14, Sheet 121). This definition recognizes this map unit encompasses erosional as well as depositional components, some of which are definitely Holocene in age. In reality, the badland area on the western end of the lake is a mosaic of variable age alluvial fan deposits draped by an irregular mantle of Holocene aeolian sediment.

Figure 11.3 shows the western basin rim on the western side of Laguna Plata, which separates the subsidence basin from the Querecho Plains (labeled "uplands" on the figure). To the east of this scarp lies a landscape that today is dominantly erosional, but that preserves fragments of previous phases of alluvial fan activity. The most prominent of the latter are shown as Late Pleistocene and Holocene alluvial fan deposits on Figure 11.4 and have been previously described as *terraces*. These deposits are elevated above the present alluvial fan channels, sometimes by as much as 6 m on the western side, but they slope towards the lake, where they may be about 2–3 m above the lakebed.

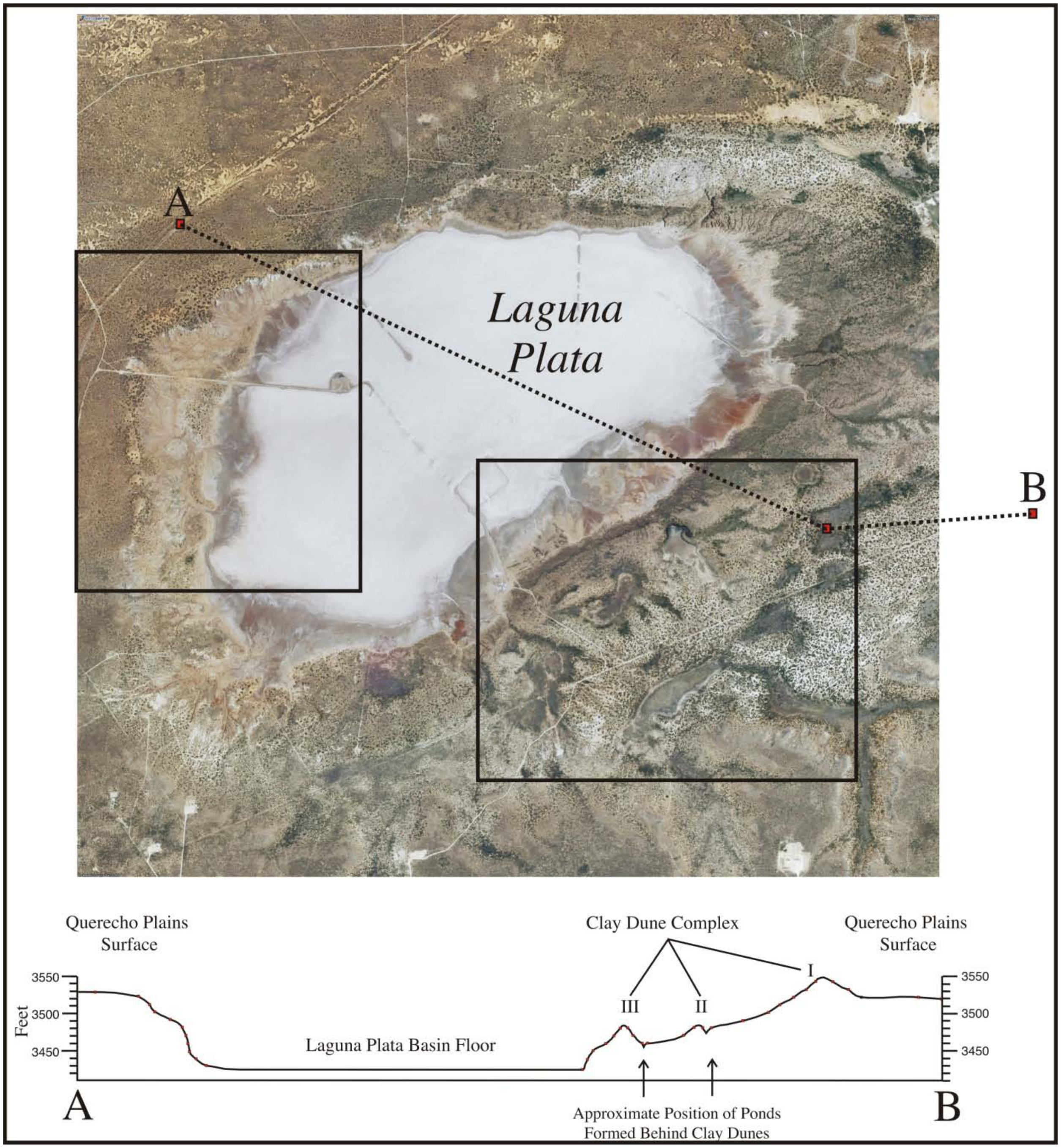

Figure 11.3 Aerial image of the central Laguna Plata Basin

Upper panel: the location of the West Side Map (Figure 11.3) is shown and the South Side Map (Figure 11.4) and the section line shown in the lower panel. *Lower Panel:* Topographic cross-section illustrating the asymmetry in the basin associated with the formation of clay dunes on the lee or east and southeast side of the basin.

Five trenches were excavated in this area in order to investigate the age and structure of the deposits present (Figure 11.5). Trench 1 was placed immediately adjacent to the lake on the alluvial fan that articulates with the surface where the original site excavations occurred. Trench 2 was placed on the same surface adjacent to the modern fan channel that drains eastward immediately north of the site. Trench 3 was placed in a bar on the floodplain of the present alluvial fan channel in order to examine the appearance and thickness of the modern fan deposits. Trench 4 was placed immediately down slope of the original site excavations, on what appeared in the field to be an older alluvial fan segment. Trench 5 was excavated across a coppice dune on the western side of the alluvial fan deposits near the south end of the site. Together with the coring in the immediate vicinity of the original excavations, these trenches provide a basic image of the age and appearance of the deposits along the western lakeshore plain.

11.4.1.1 Trench 1: Recent Aeolian on top of Late Holocene Alluvium

Trench 1 was placed in the northeastern end of the alluvial fan deposits off the northern end of the site. It was situated close to a prehistoric hearth that was eroding out of the alluvial fan deposits on the lake facing scarp about 1 m below the surface. The excavation straddled a gently convex linear bank that was thought in the field to be a thin dune. The trench was excavated about 2.9 m deep and exposed 2.5 m of middle to late Holocene age alluvial fan sediments buried by a thin aeolian veneer (see the upper half of Figure 11.6). The aeolian deposit capping the alluvial fan sediments was approximately 35 cm thick and consisted of a massive loamy sand that lacked pedogenic alteration (Table 11.3). A radiocarbon sample collected from charcoal scattered in alluvial fan sediments about 1 m below the surface yielded an age of 510±25 years B.P. (UGAMS-7211). This age indicates the aeolian veneer is quite young and is of possible Historic age. The charcoal observed in this stratum is thought to be associated with the prehistoric occupation that was observed eroding out of the lake facing scarp near the trench but no cultural material was observed within Trench 1 to support this inference. The alluvial fan sediments beneath the aeolian deposit consisted of medium to thin bedded sandy loam, loamy sand, and silt loam with minor to significant amounts of pedogenic gypsum. The gypsum was concentrated in the finer textured beds and clearly plays a role in breaking up the primary sedimentary fabric of this deposit (see Figure 11.5 for an example). The thin bedded sediments appear to represent individual flood deposits, and there appears to be a significant amount of textural variation present in the deposits. A radiocarbon age of 4690±25 years B.P. (UGAMS-7210) was obtained from bulk sediment collected from the base of the alluvial fan sediments 2.35 m below the surface and suggests the entire trench is of late Holocene age. It is possible that there are two late Holocene alluvial fan deposits present, but if this is the case it was not immediately apparent where in the section the unconformity may lie. The alluvial fan sediments rested unconformably upon Permian deposits.

Two diatom and pollen samples were submitted for analysis from Trench 1 in order to examine the preservation potential of the sediments. The upper sample was collected from zone 5 (1.35 m) and the lower sample was from zone 14 (2.42 m). Neither of these two samples contained many diatoms (see Appendix C), but the upper sample yielded two cells, one was a planktonic (floating) diatom (*Aulacoseira granulata* var. *angustissima*) indicative of a fresh to brackish water lake whereas the other was a bottom dwelling (benthic) form (*Encyonema delicatula*) indicative of fresh high conductivity water. A single diatom cell (*Nitzschia* cf. *clausii*) was recovered from the lower sample and it was a benthic form indicative of fresh to brackish high conductivity water. Pollen samples from Trench 1 (see Appendix B) also indicate preservation is poor, with the upper sample yielding a very small number of grains with pine, grass, Asteraceae and Cheno-am. The lower sample yielded no pollen. As a result, the potential of these sediments to provide a paleoenvironmental record is poor.

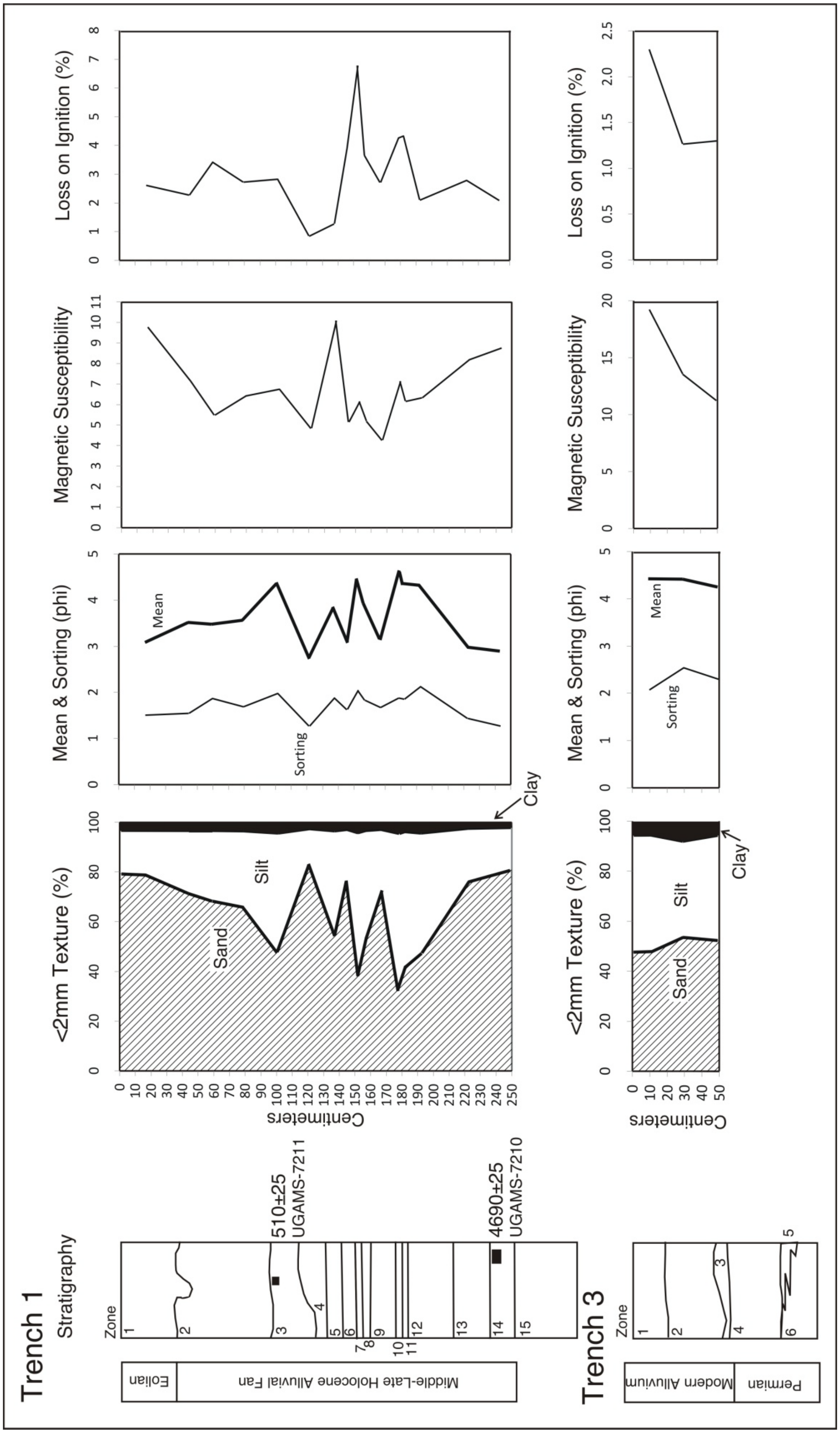

Figure 11.5 **Plot of laboratory analyses obtained from the middle-late Holocene alluvial fan deposits exposed by Trench 1, and the modern fan sediments exposed by Trench 3.**

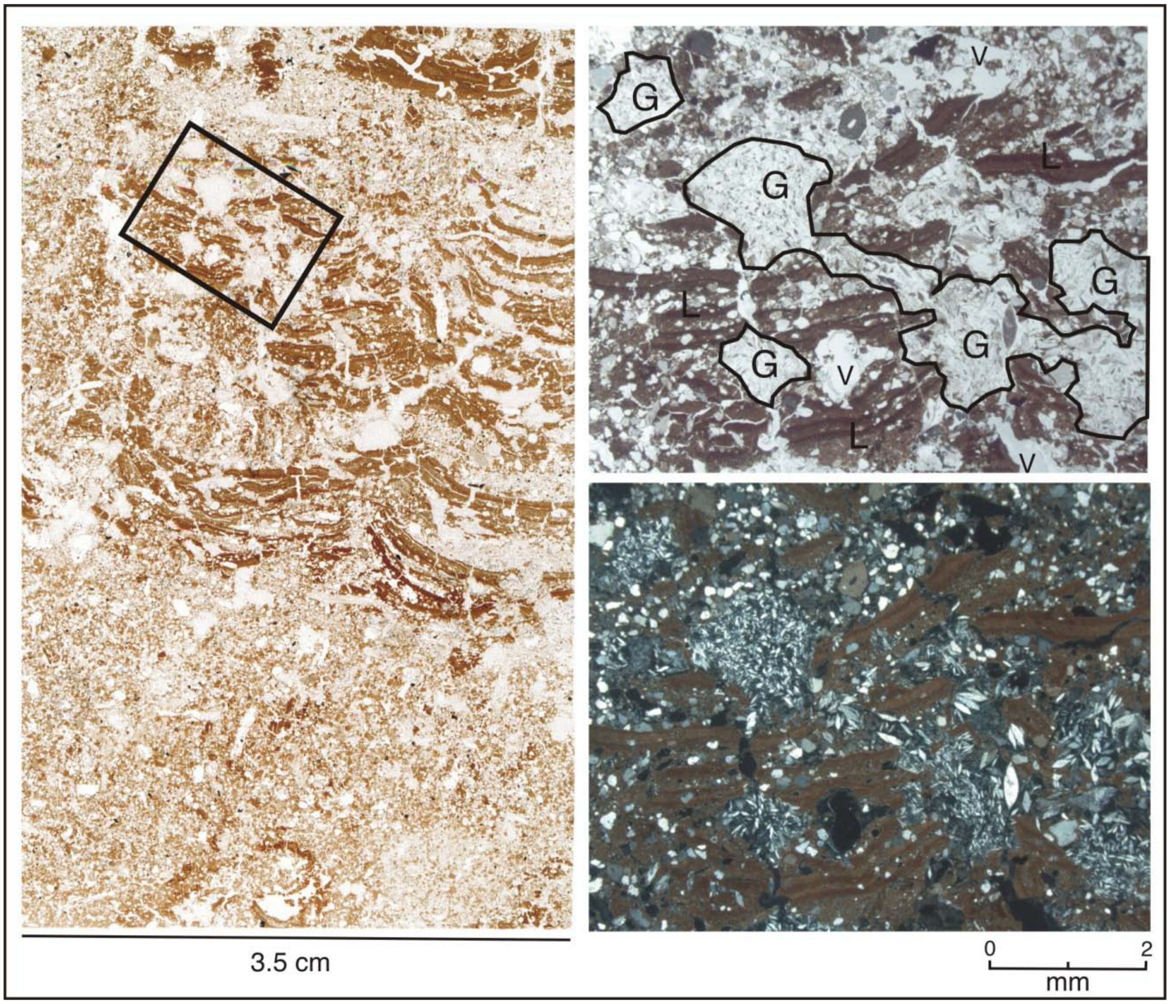

Figure 11.6 Micro-laminated sediments from Trench 1

Left side: Transmitted light scan of a thin section made from Trench 1, Zones 9, 10 and 11 (172–188 cm, showing a section of finely laminated sand and clay (upper half of the image). The micro-laminated deposits are probably individual alluvial fan floods, and comprise minute fining upward couplets that range in thickness from 0.1 to 0.5 mm thick. Black rectangle is the area shown enlarged at right. *Right side, upper panel*: Plane light image of a small section of the micro-laminated sediment showing how recently formed gypsum threads are displacing and fragmenting primary sedimentary structures. A black line traces out the newly formed gypsum threads ("G"). Vughs/pores are denoted with a lower case "v". *Right side, lower panel:* Same image as above but in cross-polarized light.

11.4.1.2 Trench 2: Recent Aeolian on top of Late Holocene Alluvium

Trench 2 was west of Trench 1, on top of what was inferred to be Late Holocene alluvial fan sediments, and adjacent to the modern alluvial fan channel. Trench 2 exposed a series of deposits very similar to those in Trench 1. The upper meter consisted of two aeolian deposits, one very recent (zones 1–3) and another slightly older (zones 4 and 5) within which an incipient soil had formed. The aeolian deposits rested unconformably upon about 1.25 m thin bedded alluvial fan sediments that contained minor amounts of pedogenic gypsum but otherwise lacked significant soil development. These deposits in turn rested unconformably upon Permian clay at 2.25 m below the surface (Table 11.3).

11.4.1.3 Trench 3: Modern Alluvial Fan Channel Bar

Trench 3 was placed west of Trench 2 on a small bar on the floodplain of the modern alluvial fan channel. The trench was excavated about 1.2 m deep, exposing a thin (ca. 55 cm), irregular veneer of recent alluvium resting unconformably upon Permian sediments. The modern alluvium was thin to medium bedded, and often laminated, and contained only very small amounts of secondary gypsum. No soil development was noted but the lab work indicated the uppermost deposit exhibited elevated magnetic susceptibility and loss-on-ignition and may have a very weakly developed A-horizon (see the lower half of Figure 11.4). The Permian deposits underlying the modern alluvium consisted of variable colored clays (greenish gray, brownish yellow and purple) and contained euhedral gypsum crystals (Table 11.3).

11.4.1.4 Trench 4: Older Fan

Trench 4 was upslope and southwest of Trench 1, just below the rise where the original site excavations occurred. It was placed here because erosional cuts adjacent to the modern alluvial fan channel immediately to the north of the trench and south of Trench 2, indicated this deposit had a different degree of soil development than the late Holocene sediments exposed by Trenches 1 and 2, and probably represented an older alluvial fan deposit.

The trench was excavated to a depth of 1.6 m and exposed a thin veneer of slopewash that covered three different age alluvial fan deposits (Figures 11.7 and 11.8). The youngest of these is presumed, on the basis of soil development, to be of Early Holocene age, and exhibited an A-Bky-Bk-C soil profile where the Bk horizon exhibited an incipient Stage II calcic horizon that contained a few (2 percent) fine (2–5 mm) calcium carbonate masses. This deposit rested unconformably upon a 43 cm-thick segment of a Pleistocene age alluvial fan (Late Pleistocene Alluvial Fan II) that had been truncated by erosion associated with the initial deposition of the Early Holocene fan deposit. The soil profile exhibited by this deposit consisted of a Bk-BC profile where the Bk horizon contained abundant diffusely disseminated calcium carbonate that Holliday and Jacobs (1995:94) have described as a Stage IIf calcic horizon. Figure 11.9 shows the interface between the Early Holocene Alluvial Fan and the Late Pleistocene Alluvial Fan II and the difference in character between the clean sands and gravels at the base of the younger deposit, and the redder, carbonate coated sands of the older, truncated Bk horizon (Table 11.3).

This deposit rested unconformably upon an older Pleistocene age alluvial fan deposit (Late Pleistocene Alluvial Fan I) which was formed in a sandy loam to a sandy clay loam within which a prominent advanced Stage II calcic horizon had formed. The calcic horizon exhibited common (4–7 percent) very coarse (20–76 mm) calcium carbonate nodules and masses. The three alluvial fan deposits exposed by Trench 4 demonstrate episodic depositional activity by this fan complex spanning the late Pleistocene and Holocene.

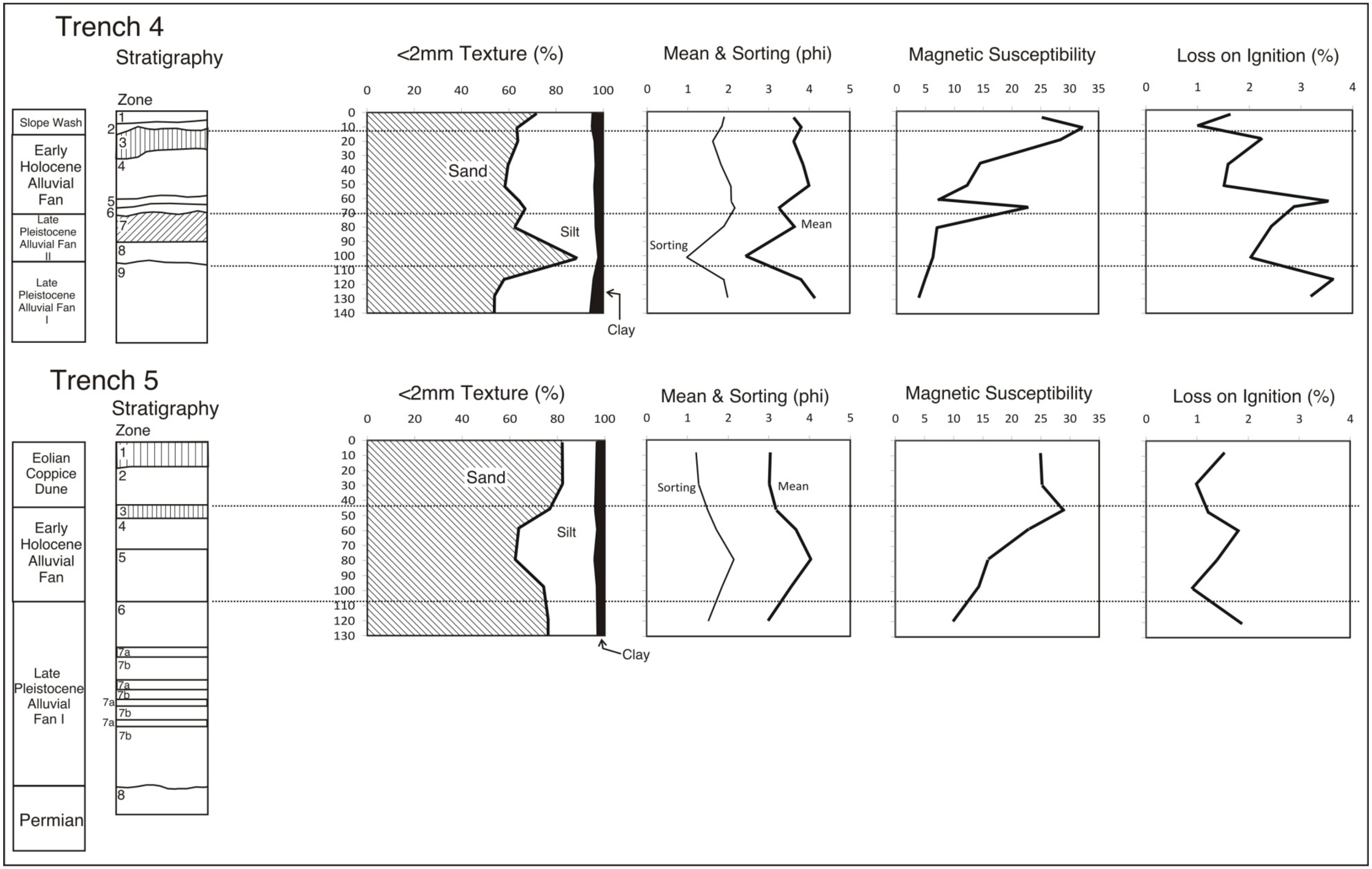

Figure 11.7 Plot of laboratory analyses obtained from the alluvial fan deposits exposed by Trench 4 and the aeolian and alluvial fan sediments exposed in Trench 5.

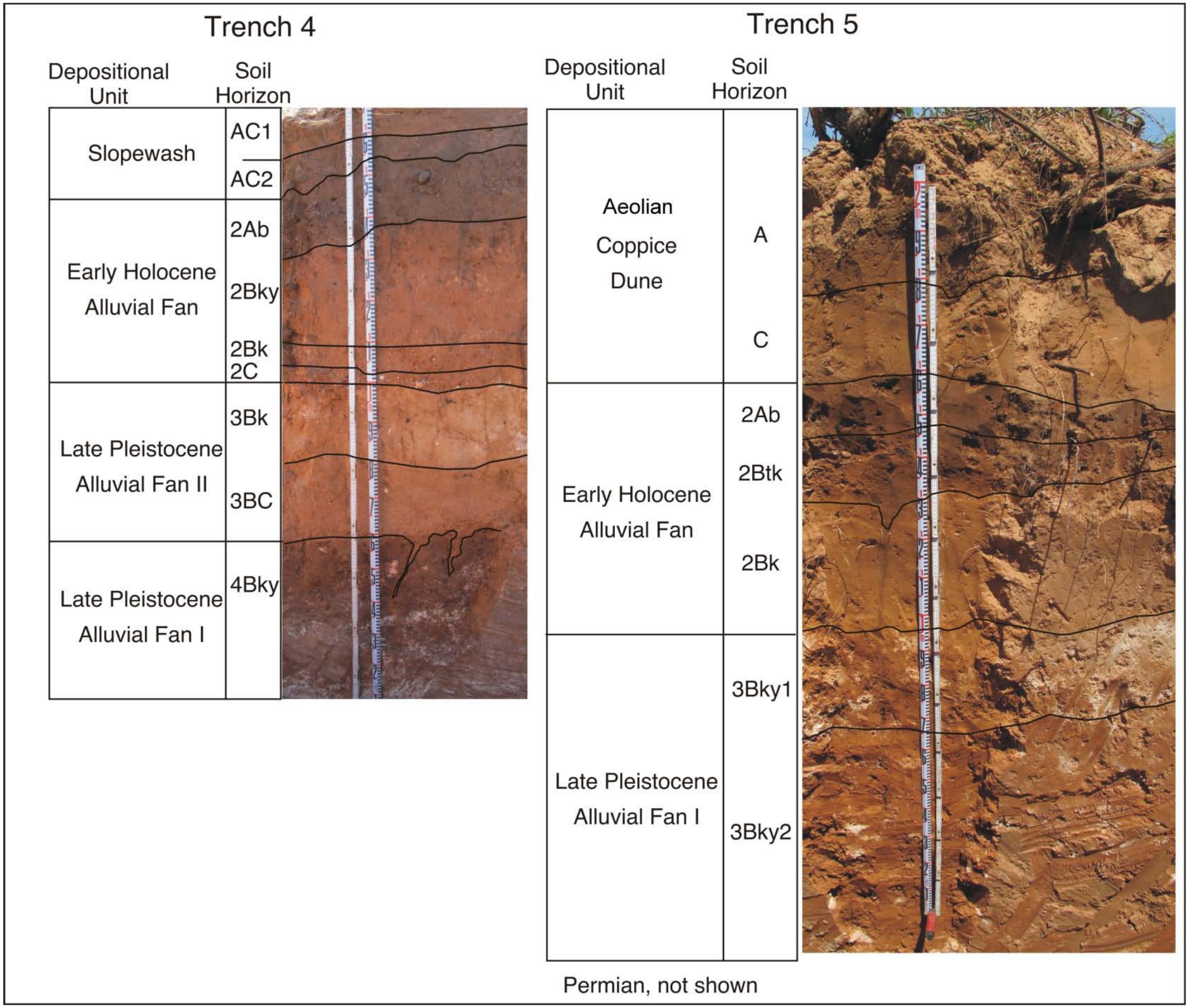

Figure 11.8 Photographs of the described profiles of Trenches 4 and 5 annotated to show the major depositional units and the soil horizons.

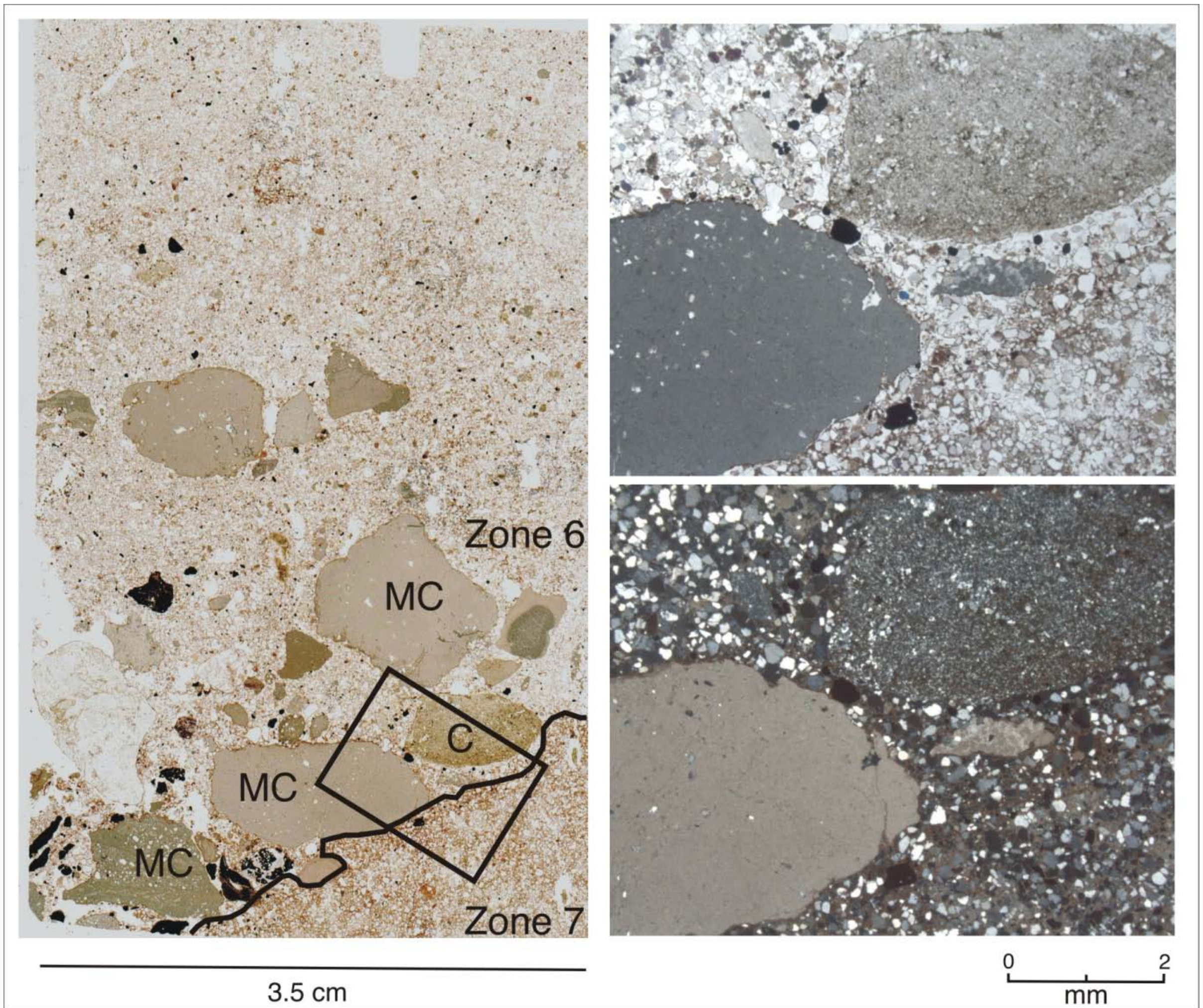

Figure 11.9 Micro-laminated sediments from Trench 4

Left side: transmitted light scan of the thin section made from Trench 4, zones 5, 6 and 7 (about 60–75 cm). A solid line denotes the boundary between gravelly zone 6 (the base of the Early Holocene alluvial fan) and the older, pedogenically altered Bk horizon of zone 7 (truncated top of the Late Pleistocene Alluvial Fan II). A clear tonal difference is visible on this scan between the clean, uncoated sands of zones 5 and 6, and the redder, carbonate coated sands of zone 7. Gravels within zone 6 include fragments of the Mescalero Caliche ("MC"; cf. Kennedy 1997) and chert ("C"). Black rectangle denotes the area shown enlarged at right. *Right side, upper panel*: Plane light image of the interface between zones 6 and 7, and a rounded clast of Mescalero caliche on the left and a rounded chert fragment on the right. *Right side, lower panel:* Same image as above but in cross-polarized light.

11.4.1.5 Trench 5: Historic Aeolian over Older Fan

This trench was excavated across a mesquite coppice dune near the south end of the site, on the western side of the elevated alluvial fan deposits. The trench was excavated to a depth of 2.5 m and exposed a recent coppice dune resting unconformably upon two different age alluvial fan deposits. The coppice dune was 42 cm thick in the described profile and exhibited an A-C soil profile formed in loamy sand. The dune buried a soil formed in a deposit that is interpreted to be an Early Holocene Alluvial Fan. This deposit was approximately 55 cm thick and exhibited an A-Btk-Bk soil profile and rested upon an eroded fragment of a late Pleistocene alluvial fan. This deposit exhibited a similar degree of soil development to the lowest alluvial fan deposit in Trench 4 (Late Pleistocene Alluvial Fan I) and is provisionally interpreted as the same deposit (Table 11.3).

Table 11.3 Summary of the deposits exposed by trenching on the western lakeshore plain near the Laguna Plata Site.

Deposit	Location (Trench number)	Color	Calcic Horizon Stage	Texture	Bedding	Soil Horizon Profile	Age
Modern Alluvial Fan	3	5 YR hue	none	Sand, sandy loam	Thin bedded, laminated	None; minor amounts of secondary gypsum	<500 years
Late Holocene Alluvial Fan	1, 2	Mostly 5YR hue	none	Loamy sand, sandy loam, silt loam	Thin to medium bedded, occasionally laminated	Pedogenically unaltered except for significant amounts of pedogenic gypsum	500 to 4800 years BP Radiocarbon ages: • 510±25 (1 m) • 4690±25 (2.35 m)
Early (?) Holocene Alluvial Fan	4, 5	7.5YR and 5YR hues	Weak stage II to Stage I	Sandy loam		A-Bky-Bk-C	unknown
Late Pleistocene Alluvial Fan II	4	5YR hues	Stage IIf to IIIf	Sandy loam	massive	Truncated Bk-BC	unknown
Late Pleistocene Alluvial Fan I	4, 5,	2.5YR hues	Prominent Stage II with very coarse carbonate nodules	Loamy sand, sand, sandy clay and clay	massive	Truncated by erosion-Bky-R	unknown
Historic aeolian (coppice dunes and sand sheets)	1, 2, 5, and 8	A horizon: 10YR 4/3 C horizon: 7.5YR	none	Loamy sand	Massive to faintly laminated	Pedogenically unaltered to A-C	<500 years in trench 1
Latest Holocene Inter–Clay Dune Pond	6	10YR, 7.5YR and 2.5Y hues	None	Sand, sandy loam, loam and clay	Thin to medium bedded	A-C	<300 years
Holocene Clay Dunes	7, and 8	5YR and 7.5YR hues	Stage II in Late Holocene Age sediment	Variable, sandy to clay; no analytical work done	Massive to faintly bedded, occasionally laminated	Bky1-Bky2-Cy	Crest of Dune II is active in the Late Holocene (ca. 3,400-3700 years BP); Core of dune is of unknown age

11.4.2 Road Cut Exposure of Lacustrine Sediment

The oil field road that bisects the site exposes a wedge of late Pleistocene age lacustrine sediment that pinches out immediately west of the point it was described, and thickens to at least 1.5 m in the direction of the modern lake. This deposit consists of pale olive to pale yellow sandy loam to clay loam and contains abundant large crystals of gypsum. In the describe section the gypsum crystals are relatively small (4–5 mm) but in the exposures closer to the lake large crystals upwards 5–7 cm are present. The deposit rests unconformably upon late Pleistocene age alluvial fan sediments, and the base of the lacustrine unit and the underlying alluvial fan deposits contain a small amount of gravel.

The fact that this deposit contains gypsum and not halite (which is currently precipitating on the basin floor) suggests a change in lake chemistry has occurred since this sediment was deposited. The fact that the topographic map of Laguna Plata notes the western half is a disposal pond suggests the halite on the basin floor is from disposal of oilfield brines and is not a natural feature of the lake. The stratigraphic affinity of this deposit is unknown, but it may be either Tahoka Formation or Double Lakes Formation (cf. Reeves 1966, 1991), but the general appearance of the deposit appears to be most consistent with the Tahoka formation as described in Reeves (1991). The fact that this deposit is about 2–3 m above the modern basin floor is a testimony to the amount of aeolian deflation that has occurred during the Holocene.

Two samples of this deposit were collected to check for preservation of diatoms. The upper sample was collected from 43 cm in zone 3 of the road cut exposure, and a second sample was collected from 60 cm (zone 4). The lower sample was devoid of diatoms but the upper sample yielded 5 cells of *Reimeria sinuata*, which is found in fresh to brackish running water (Appendix C), which might be consistent with a lake shore facies. It is telling that a sample of black mud derived from the basin floor near the western shoreline yielded only one diatom cell as well.

11.4.3 Original Site Excavation Cores

A suite of four cores were collected in a north-south transect across the knoll where the original site excavation was located. The stratigraphy revealed by these cores is shown in general terms on Figure 11.10 and described in Table 11.4. At the northern end of the knoll a thin veneer of recent aeolian sand was present, but was not observed in the southern two cores. Below this sand was a massive, very organic rich A-horizon that contained cultural material and is inferred to be at least partly anthrogenic in origin. The base of this deposit was generally gradational to a reddish brown sand that is most likely a Pleistocene alluvial fan deposit. Beneath this was a highly variably colored sandy deposit that was green or yellow down slope and that pinched and became slightly redder and partially indurated upslope. This deposit contained euhedral gypsum crystals and many gypsum threads, and may be a lacustrine deposit that, given its relative elevation, predates the Tahoka Clay, such as the Double Lakes Formation (Reeves 1991). This deposit was indurated in the upslope cores, but not in the down slope cores. It rested upon a red sand and clay that appeared to be Permian in age.

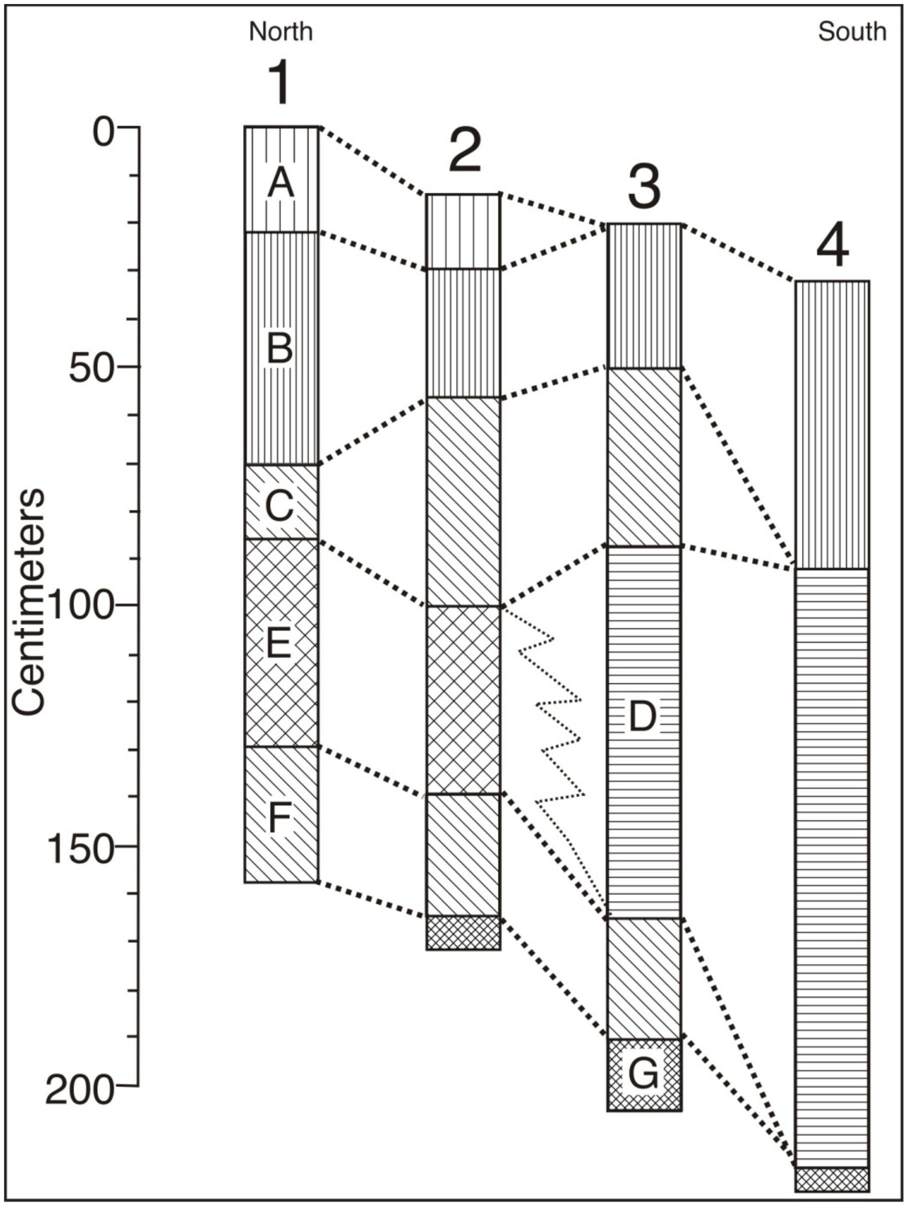

Figure 11.10 **Schematic log showing the stratigraphy in the cores collected near the original site excavation.**

The scale is correct for each core, but the height between cores is estimated and most likely incorrect, but intended to show that the surface examine sloped slightly to the south.

Table 11.4 List of deposits observed in the cores near the original site excavation.

Deposit	Lithology and Color	Interpretation
A	Brown (7.5YR 5/4, d to 7.5YR 4/3, d) sand and loamy sand, within which a weakly developed A horizon was formed, slightly effervescent, abrupt smooth boundary.	Recent aeolian (modern)
B	Dark grayish brown (10YR 4/2, m) to very dark grayish brown (10YR 3/2, m) loamy sand to sandy loam, strongly to violently effervescent, gradual smooth boundary, contains cultural material in some places. In 3 of 4 profiles it exhibited a brown (7.5YR 5/3, m) loamy sand less melanized base.	Cumulic aeolian deposit and/or weathered alluvial fan sediment, substantially altered by human activity.

Deposit	Lithology and Color	Interpretation
C	Light reddish brown to reddish yellow (5YR 6/5, m) to light brown (7.5YR 6/4, m) loamy sand to sandy loam, common (7–20%) white gypsum threads.	Pleistocene alluvial fan sediment?
D	Pale yellow (5Y 7/3, m) and pale olive (5Y 6/4, m to 5Y 6/3) loamy sand, and sandy loam, violently effervescent, many gypsum threads (5–15%) and occasional subhorizontal gypsum crusts.	Possibly Pleistocene lacustrine; thickens downslope toward lake.
E	Alternates light reddish brown to reddish yellow (5YR 6/5, m) to light brown (7.5YR 6/4,m) sandy loam and white (10YR 8/2, m) to pink (7.5YR 7/3, m) sandy loam, locally indurated in places, violently effervescent, looks like a boxwork calcrete in some sections, and laminated calcrete in others, common to many (5–15%) light olive brown (2.5Y 5/4) euhedral blade-like gypsum crystals.	Probably upslope facies of Unit D, duricrust formed in littoral lacustrine deposit?
F	Yellowish red (5YR 5/6, m) sand to loamy sand, strongly to violently effervescent, common (5-7%) gypsum threads, weakly indurated in places, laminated in places, contains a few siliceous gravels in one core.	Permian bedrock
G	Yellowish red (5YR 4/6, m) to reddish brown (5YR 4/4, m) clay, firm, slightly effervescent, common (5–7%) gypsum threads, few 2 cm diameter calcium carbonate nodules.	Permian bedrock

11.4.4 Depositional Structure of the Western Lakeshore Plain: Clay Dunes and the Inter-Clay Dune Ponds

The results of the trenching and pedestrian reconnaissance of the western lakeshore plain in and around the Laguna Plata site demonstrates there are multiple late Pleistocene and Holocene alluvial fan deposits present in this area. These deposits are generally oldest on the west side and become increasingly younger to the east (toward the lake). Although the small number of widely spaced trenches precludes any solid understanding of the stratigraphic structure of these deposits, the impression from the fieldwork is that the largest single body of sediment is of middle-late Holocene age and lies adjacent to the lake. Trenches 1 and 2 exposed this deposit and another lobe of sediment that was thought to be of similar age was observed south of the site. The older deposits generally appear to be present as thin, truncated veneers that presumably would have thickened toward the lake. Subsequent activity of the fan has undoubtedly eroded some of these deposits.

Exposures along the oil field road that bisect the site indicates there is a late Pleistocene lacustrine deposit that is also present in this area (presumably the Tahoka Clay), which rises and pinches out to the west and thickens to the east, but is eventually truncated adjacent to the modern lake shore. This deposit is 2–4 m above the present day lake and implies a similar magnitude of wind deflation of the basin floor during the Holocene, which contributed to the formation of the clay dunes on the east and south sides of the basin. A second, presumably older, lacustrine deposit was encountered during coring of the highest surface along the western margin of the site, and this deposit may be the Double Lakes Formation.

The progressive desiccation and aeolian deflation of the Laguna Plata basin during the late Pleistocene and Holocene has resulted in the formation of at least three fairly prominent clay dunes that lie on the eastern side of the present lake basin, here described as Series I, II and III (Figures 11.11 and 11.12). The crest of the largest of these clay dunes (Series I) lies about 1.3 and 1.9 km from the present lake margin and rises to an elevation of approximately 3350 ft above sea level. The dune crest is about 40 ft above the level of the Querecho Plains on the east side of the basin and is about 130 ft above the present basin floor. The dune is of variable width, ranging between 0.5 and 1 km and lies almost due east and southeast of the lake. The intermediate dune (Series II) rises to an elevation between 3490 and 3530 ft above sea level, and is highest on the east and northeast side of the basin. Unlike the Series I dune, the Series II dune wraps around the north and south sides of the lake. On the southern side of the lake the Series II dune is less prominent than it is on the north and east sides, and this dune ranges from 0.3 to about 0.6 km wide. The youngest dune, Series III, is best defined on the southeastern lakeshore, and abuts the modern lake. This dune has been broken into a series of small segments by streams draining the other dunes, and these segments have crests that lie between 3450 and 3490 ft above sea level. This dune is about 300 m wide. At the far eastern end of the Laguna Plata basin, well away from the modern lake, there appears to be vestiges of another clay dune. This dune is here considered speculative as it was not examined in the field, and exhibits relatively subdued topography. If this feature is a clay dune, it should predate the Series I dune.

Figure 11.11 Photograph looking north from the lake bed of Laguna Plata

Photo shows the scarp that defines the eastern side of the Late Holocene alluvial fan deposits. Visible on the lake bed on the left side of this photo are cross-bedded Permian sandstone deposits.

As noted previously, clay dunes generally fringe the active lake, and therefore are often thought of as features that denote the approximate lake shore at different times in the past. As the lake desiccates and the dunes grow in height they block off surface drainages and gradually fragment the former lakebed into a series of ephemeral wetlands (Lees 1989). This is clearly visible east of Laguna Plata where there are at least two, but arguably three, sets of enclosed depressions that pond water. The most prominent of these are the discrete ephemeral ponds that lie immediately east and south of the Series III dune. At least four distinct wetland depressions lie behind the series III dune, two of these have been broached by runoff where water has eroded across the youngest clay dune and now freely drain into Laguna Plata, but the other two depressions appear to be undrained. A second series of ponds are between the Series I and II dunes on the southeast side of the lake. There is also a closed depression due east of the series I dune and it appears to be rimmed by a low ridge which, as noted earlier, could be yet an older clay dune, but this feature is much less well defined than the aforementioned dunes. The whitish color of the exposed ground in this area (when viewed from aerial images) lends some support to this argument, and stands in stark contrast to the more yellow color associated with the Mescalero sand dunes on the adjacent Querecho Plains.

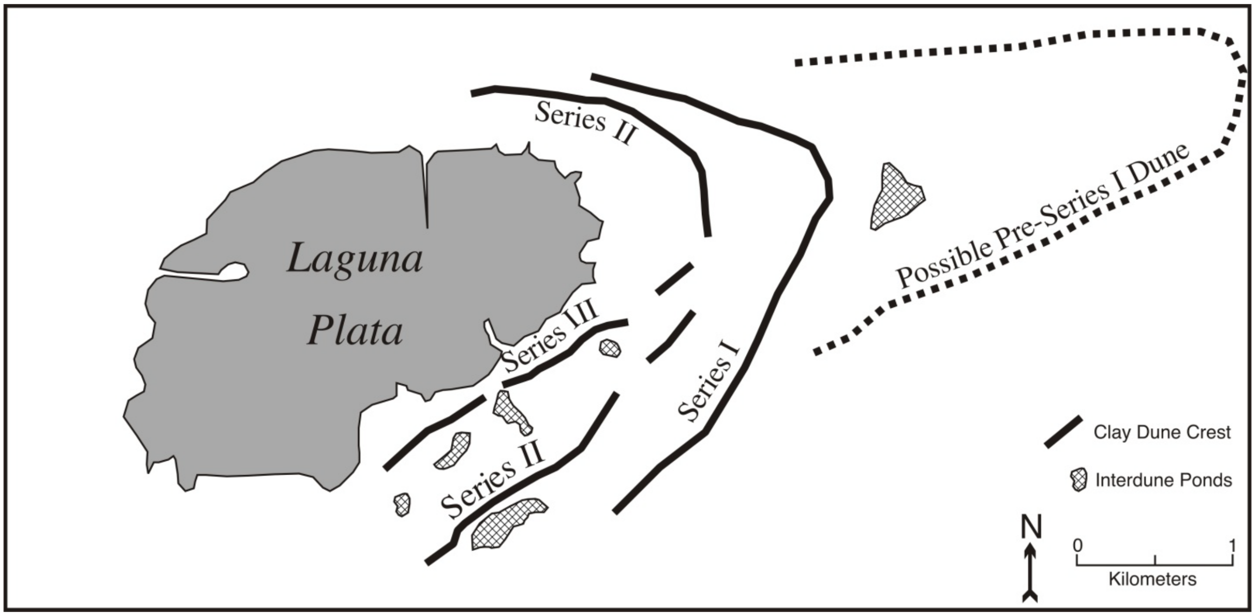

Figure 11.12 Simplified line drawing showing the relative location of the different clay dunes discussed in the text.

11.4.4.1 Field Investigations

Three trenches were placed in the area of clay dunes on the southeastern side of the lake (Figure 11.13). Trench 6 was placed in the margin of one of the drained ponds, and Trenches 7 and 8 were placed in clay dunes in the same area, with Trench 7 placed in an eroded ridge that is probably part of the Series III dune, and Trench 8 is on the northern flank of the Series II dune.

11.4.4.2 Trench 6: Inter-Clay Dune Pond

Trench 6 was excavated into the northeastern margin of one of the drained ponds formed behind the Series III clay dune. The trench was dug about 1.6 m deep and exposed a thin (about 1 m) veneer of alluvial/lacustrine sediment resting upon Permian clay. The loamy sand to sandy loam alluvial/lacustrine sediments exhibited a very weakly developed A horizon at the top of the profile, and were essentially unaltered by pedogenensis below this, which implies a relatively young age. Several bison bones were encountered within Zone 8 at a depth of about 80 cm. One of the bison bones was radiocarbon dated and yielded an age of 280±27 years B.P. (UGAMS-7214). The presence of bison bones in this setting implies the water within this depression was potable to wildlife, and the results of the diatoms samples collected from this trench support this interpretation.

Three samples collected from Trench 6 were submitted for diatom and pollen analysis and were the most promising feasibility samples examined during this study. Although none of the diatom samples were highly productive, they were more productive than most of the samples submitted from the other trenches. Two of the three samples yielded small numbers of Chrysophyte cysts which are generally associated with freshwater lakes that are low in nutrients (Appendix C), and several of the diatoms recovered from these deposits are associated with either fresh or brackish water. Pollen analysis of these three samples (Appendix B) was relatively promising, with two of the three containing reasonably high pollen concentration and a diverse range of taxa present, including pine, juniper, elm, sage, Mormon tea, as well as grass and Cheno-am.

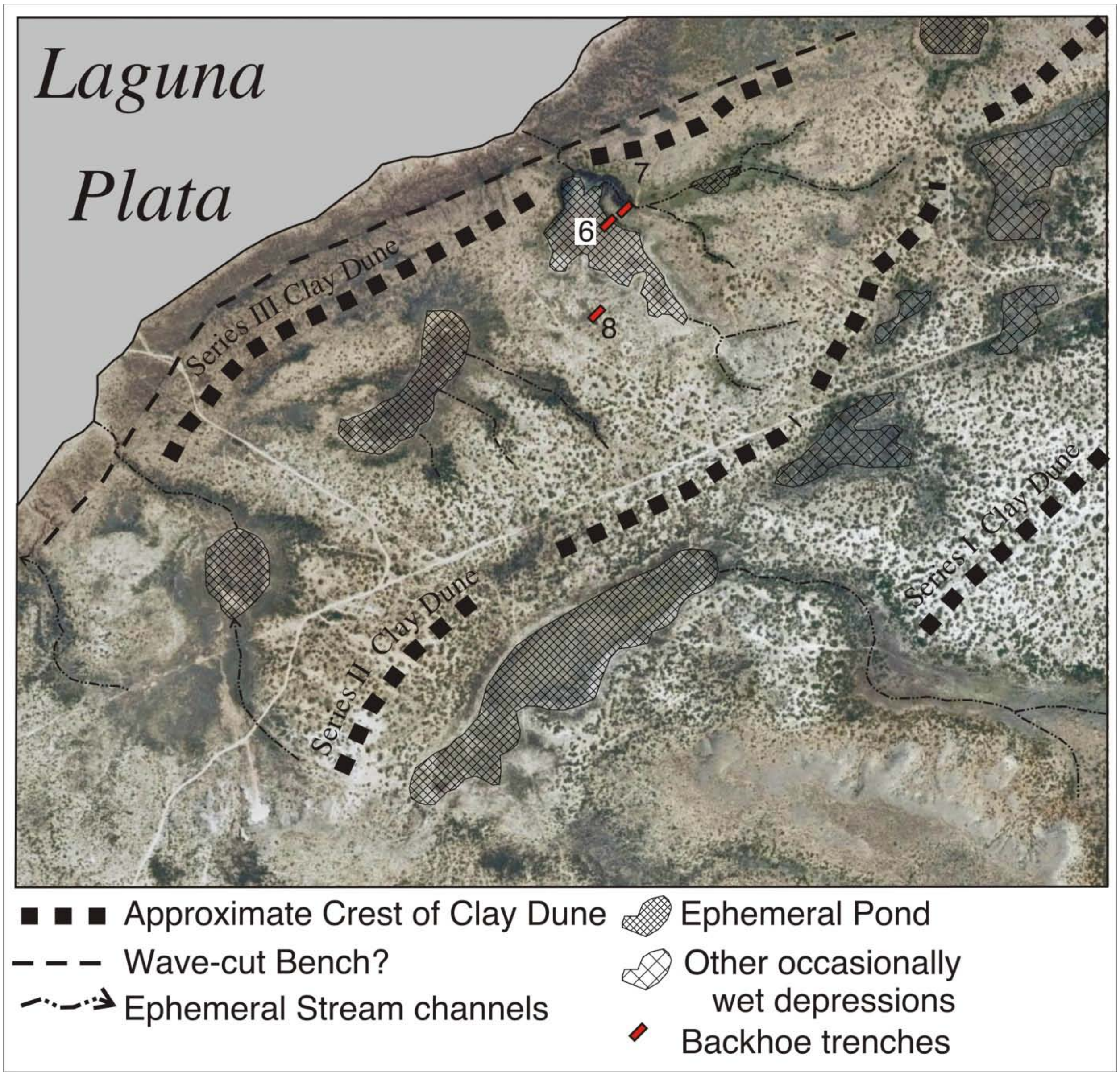

Figure 11.13 Annotated aerial image of the southeastern side of the Laguna Plata basin

Shown are relevant geomorphic features (e.g., clay dunes, streams, and ephemeral wetlands) and the location of trenches 6, 7 and 8.

The pond that was trenched now freely drains into Laguna Plata and the deposits exposed on the basin floor were clearly alluvial in places, and this may account for the relatively thin and young sedimentary sequence present. It is likely that the two depressions behind the Series III dune that are not connected with Laguna Plata may yield longer sedimentary sequences, and possibly a more productive pollen and diatom record. Unfortunately, there was insufficient field time to examine these basins in the detail they merit.

11.4.4.3 Trench 7: Clay Dune

This trench was placed on a narrow interfluvial ridge immediately northeast of Trench 6. This clay dune sediment was probably deposited as part of the Series III clay dune, but the local topography today is associated with erosion by running water that is shed from the surrounding dunes. The soil exposed along the crest of this small ridge was truncated by erosion and the underlying sediments were clearly stratified, and contained a considerable quantity of gypsum. In the field the top 11 cm (the By horizon) was estimated to have about 80 percent gypsum, but a sample was collected for thin section to examine this more closely. Figure 11.13 shows several views of this deposit in thin section. The clay dune deposit appears to be composed of a mixture of fragments of mud (the darker colored fragments visible in the upper right part of Figure 11.13), subrounded quartzose sand grains, and relatively large, euhedral gypsum crystals. Secondary gypsum accumulation in the form of thread-like accumulations dominate this slide but are difficult to identify in plane light images and are most easily seen in cross-polarized light. The neo-formed gypsum crystals are very small (about 0.1 mm) and form 1–2 mm wide linear patches, which displace the original sedimentary matrix as they grow. The extensive gypsum in this deposit is most likely in part detrital and part secondary dissolution and reprecipitation of gypsum by infiltrating meteoric (rain) water.

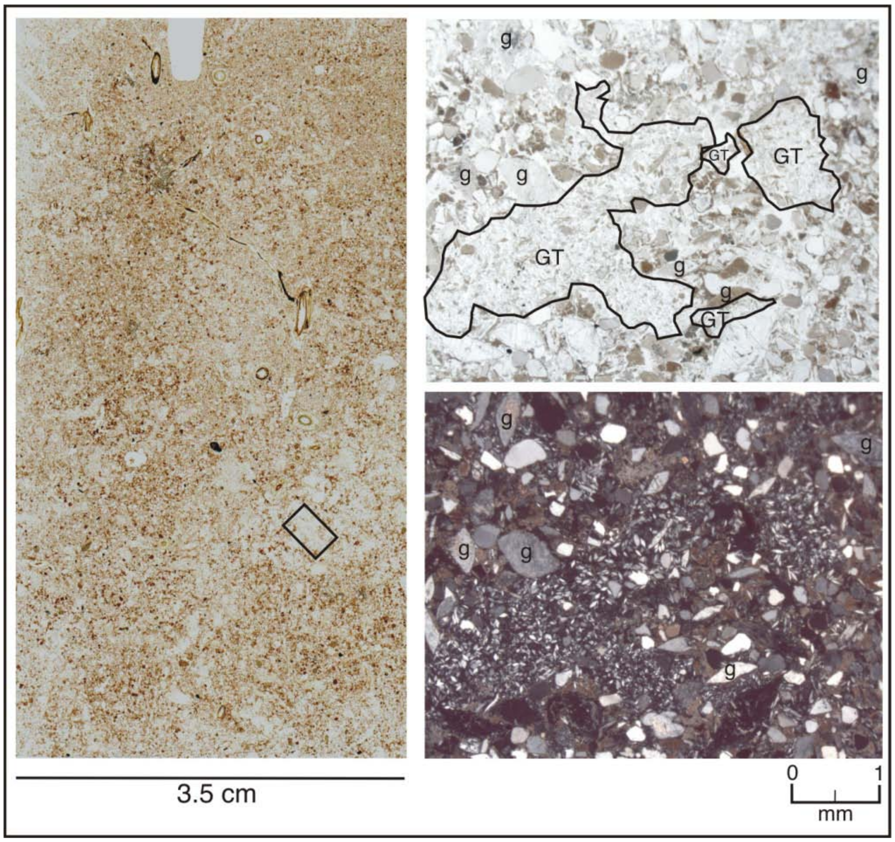

Figure 11.14 Micro-laminated sediments from Trench 7

Left side: Transmitted light scan of thin section obtained from Trench 7, zones 1 and 2 (2–18 cm). The small rectangle is the area shown enlarged at right. *Right side, upper panel*: Plane light image of a 1–2 mm wide gypsum thread (GT, highlighted with a black line) recently formed in clay dune sediments. The slightly darker colored material outside the gypsum thread is primary clay dune sediment, and the large gypsum crystals (“g”, 0.5 to 1 mm long) were probably deflated from the lake bed. *Right side, lower panel:* Same image show above but in cross polarized light which more readily shows the lozenge-shaped gypsum crystals.

11.4.4.4 Trench 8: Clay Dune

Trench 8 was on the northern slope of the Series II clay dune, on a relatively flat crested hill overlooking the small pond where Trench 6 was located. Trench 8 bisected a mesquite coppice dune on this surface, and the coppice dune was more than 20 cm thick, but the loose sand and extensive roots conspired to limit the profile to the margin of the coppice dune. As with other coppice dunes, this deposit exhibited an A-C soil profile and rested unconformably upon a truncated soil formed in the underlying clay dune.

Approximately 1.8 m of stratified clay dune sediments was exposed beneath the coppice dune. The soil formed in the clay dune exhibited a Bky1-Bky2-Cy profile, where the calcic horizon exhibited a stage II (nodular) morphology with 7–10 percent small (2–5 mm) calcium carbonate masses and numerous gypsum threads. Two burnt surfaces were observed buried within the upper part of the clay dune deposits, and these surfaces appear to represent grass fires judging by the carbon isotopic signature of the dated material (-8.9 and -13.1 per mil PDB), the evidence of which was preserved by rapid aeolian sedimentation. The upper burn yielded a conventional radiocarbon age of 3470±26 years B.P. (UGAMS-7213) and the lower burn yielded an age of 3660±25 years B.P. (UGAMS-7212). It is interesting to note that ephemeral grass fires were also found within the youngest clay dune adjacent to Red Lake, which was studied by Quigg et al (1993). The late Holocene age for these two grass fires are in correct stratigraphic order lending additional support to the results, but this is surprisingly young for a Stage II calcic horizon, which going by previous work on calcic horizon formation from the Desert Project (e.g., Gile et al. 1981) would generally be inferred to be either a Late Pleistocene or Early Holocene age.

11.4.5 Discussion of the Clay Dunes and Inter-Clay Dune Ponds

The road into the area where these three trenches were placed follows along the crest of the Stage II or middle clay dune and there is abundant cultural material exposed among the coppice dunes adjacent to the road. It is clear that this margin of the Laguna Plata basin in general, and the crest of this clay dune in particular, were frequently inhabited in the distant past. Today this large clay dune is mantled with Historic age mesquite coppice sand dunes, as is much of the surrounding upland landscape on the Querecho Plains, and it is tempting to think that this aeolian landscape is similar to the larger Mescalero Sands described in detail by Hall (2002a, 2002b) and Hall and Goble (2008), but this is not the case.

The Late Quaternary geologic history of Laguna Plata and the clay dunes are intimately, but inversely, related. In the late Pleistocene, when there was more effective precipitation and less evaporation, Laguna Plata, like most of the playas and salinas in this region, held water and accumulated lacustrine sediment now called the Tahoka Clay. This lacustrine mud has been dated elsewhere on the Southern High Plains to the period between approximately 22,000 and 12,500 years B.P. (Reeves 1991:485). While the lake was full, there was no sediment source for the dunes, and dune formation, if it occurred, was restricted to periods of drought that would expose small portions of the lakebed. As the climate warmed and evaporation increased, the lake began to shrink significantly, exposing increasingly large portions of the lakebed to desiccation, where gypsum salts crystallized in the basin floor muds and created puffy mud crusts from which the wind blew sand sized fragments to the margin of the lake and the vegetation that fringed the lake shore trapped the mud curls. There these fragments of mud began to form a large dune along the lakeshore that gradually began to develop the crescentic shape from which these dunes derive one of their names, lunettes. With the passing of time, the lakeshore receded more and a second dune began to form a little west of the first. As it grew larger the new dune gradually blocked the small ephemeral streams that drained the first dune, forming a series of ephemeral wetlands and ponds that were fed by runoff as well as springs. Eventually a third dune also formed in the same manner and created another series of ponds, although several of the youngest ponds managed to spill over the youngest dune and drain into Laguna Plata. Dunes such as these are known from previous work to support freshwater springs, which are presumed to have flowed even during periods of aridity, thereby acting as points of attraction for human populations (Wood et al. 2002).

When the different Laguna Plata clay dunes began to form is unknown and the literature is relatively uninformative as this coupled geomorphic system remains one of the least studied landform constellations in the region. The only study to examine the age of a lunette adjacent to a salina (Rich et al. 1999; Wood et al., 2002), as opposed to one of the smaller and more numerous playas, examined a single dune adjacent to Double Lakes in Lynn County, Texas. It was not a nested series of dunes such as is present at Laguna Plata, or previously described by Reeves (1965) or Quigg et al. (1993). However, the results of the Double Lakes lunette study found, not unexpectedly, that the clay dune grew most during periods of aridity around 11,500±1100, 6500±700, and 4900 ± 500 years B.P. The next older period of clay dune formation observed by Wood et al. (2002) dated to the period between 96,000 and 122,000 years B.P. The chronology of nested clay dunes, such as the lunettes around Laguna Plata, is most likely more complex than that observed by Wood et al. (2002) but it is apparent that both radiocarbon and optically stimulated luminescence (cf. Brook et al. 2007; Holmes et al. 2008; Rhodes and Rich 2004; Rich et al. 1999; Wood et al. 2002) can be used to construct a chronology of dune formation. Although the major question at this time concerns the chronology of the major clay dunes, the results of this opportunistic foray into this landscape suggest these are highly dynamic depositional environments, and that they may preserve both archaeological and paleoenvironmental records.

11.5 Discussion of the Laguna Plata Basin and its Archaeological Potential

11.5.1 Archaeological Visibility as a Function of Late Quaternary Landscape Dynamics

In general terms, there is an inverse relationship between sedimentation rate and visibility. Landscapes and landforms with high sedimentation rates generally exhibit low archaeological visibility where as those with slow or negligible sedimentation rates have high archaeological visibility. Most Quaternary depositional environments exhibit episodic sedimentation, and experience a phase of relatively rapid deposition, followed by long periods of stability or erosion. As a result, the archaeological visibility associated with a given sedimentary deposit is different between its core and its final surface. In the absence of built anthrogenic environments where there can be isolated high sedimentation rate settings within a larger much slower sedimentation rate landscape, archaeological sites with low sedimentation rates are generally less interpretable than sites with higher sedimentation rates owing to the deleterious effects of *time averaging*.

Paleontologists use the term time averaging to refer to “the process by which organic remains from different time intervals come to be preserved together” (Kidwell and Behrensmeyer 1993:4) and often construe this as a form of “blurring” of the stratigraphic record which limits one’s ability to resolve the record into fine time slices (Graham 1993:105). A number of different processes can contribute to the formation of time-averaged assemblages in nature, with the two principal processes being slow or non-sedimentation, and mixing. All of the earth’s surfaces exhibit time averaging, but in rapidly aggrading settings this may be measured in seconds to years, whereas surfaces exhibiting long periods of time averaging may experience surface exposure that is best expressed in centuries or millennia. Time averaging is of course, a gradational phenomenon, with all sites, by definition, including some measure of it. However, the process becomes deleterious when it results in sufficient overprinting that it obscures trends or events than may once have been clear, or when it results in the co-mingling of material from two or more significantly different periods. The challenge with any landscape is how to find and target the best, most interpretable archaeological record so as to maximize the return on our archaeological investment.

Sites discovered through pedestrian survey typically identify either occupations on surfaces with significant periods of time averaging, or fragments of buried but eroding sites that may be present on surfaces with significantly less time averaging. Archaeological sites buried in rapidly aggrading sedimentary environments with short periods of time averaging may preserve sites of a Pompeiian-like character, where sedimentation preserves snapshot like images of inhabited surfaces that preserve activity areas in exquisite detail (cf. the Rush Site (Quigg and Peck 1995), or the Elm Creek site (41CN95), and the Rocky Branch Site (41RN3; Treece et al. 1993) for some examples in western Texas. However, finding these kinds of sites is a needle in the haystack proposition unless one can use some other factor to narrow the geographic search. The landscape surrounding Laguna Plata presents a diverse suite of settings for human habitation. Some of these have been stable and exposed for a very long time, whereas others have experienced periods of rapid sedimentation and, therefore, exhibit low archaeological visibility but potentially sites with high stratigraphic integrity.

11.5.1.1 The Western Lakeshore Plain

Trenching in and near the Laguna Plata site exposed a complex series of different age alluvial fan deposits along the western lakeshore plain. These deposits presently are 2 to 6 m above the modern fan channels and range in age from Late Holocene to Pleistocene. The original site excavations are situated upon the oldest and highest of these alluvial fan deposits and, as such, this surface exhibits a profound degree of stratigraphic compression owing to a long period of time averaging. The high archaeological visibility of this area has attracted surface collectors for quite some time. Conversely, Trench 1 exposed Late Holocene age alluvial fan sediments with prehistoric occupations, which appeared to be of similar age to the excavated site, but possessing much lower archaeological visibility. Although it is difficult to identify the main loci of activity of this deposit, it clearly preserves *in situ* Late Holocene archaeology and the low degree of archaeology visibility tends to afford a degree of protection. Indeed, the low ubiquity of artifacts on the surface in and around the Late Holocene alluvial fan deposits resulted in some of the Laguna Plata site's best contextual integrity not even being included within the revised site boundary (such as the material eroding from the lake facing scarp near Trench 1) and only included in the site where erosion by gullies exposed a broad surface of cultural material (e.g., near Trench 2). It is probable that the Late Holocene alluvial fan deposits nearest the lake contain some of the best preserved sites in this portion of the basin, but are poorly known owing to their low archaeological visibility.

Results from the pollen and diatom feasibility studies indicate that it is unlikely that evidence of the paleoenvironmental record will be forth coming from the alluvial fan deposits on the western shore.

11.5.1.2 The South and Eastern Basin Clay Dunes

As noted previously, the clay dunes represent a major re-organization of the sediments within the Laguna Plata basin that has occurred in the period since the end of the Pleistocene (since approximately 12,500 years B.P.). This reorganization has seen more than 2 m of sediment eroded from the lake bed and redeposited in a series of arcuate-shaped clay dunes or lunettes on the eastern side of the lake. This process created a series of ephemeral wetlands that are supported by runoff in addition to springs, and this area has a high potential for buried archaeological sites in their primary context, as well as a potential for a paleoenvironmental record from the ponds. Results of the feasibility studies found the deposits of one of the ephemeral ponds to have marginal diatom preservation and reasonably good pollen preservation, and the pond examined is, in retrospect, one of the least promising in this portion of the basin, given that it freely drains into Laguna Plata and may behave more like a stream than a pond today.

The presence of known springs (see the topographic map; Wood et al. 2002), together with episodically aggrading surfaces adjacent to a water body that might have attracted migratory water fowl, seems to present a tempting archaeological landscape with great potential that has been relatively untapped.

12.0 Lithic Debitage Analysis

Peter c. Condon and Benjamin G. Bury

This chapter presents analysis of lithic debitage recovered by the LCAS and TRC during this testing project. Issues pertinent to this analysis address technological organization, including raw material selection, lithic debitage analysis, and flaked-stone tool manufacture. The analytical method discussed herein is primarily based on an attribute-level of classification. As briefly discussed with regional lithic analysts, no single lithic attribute can accurately identify or characterize a lithic assemblage with regard to technology or technique, therefore, a cumulative data set is presented that builds upon individual attribute categories (Carr and Bradbury 2001:134). This analysis strategy involves characteristics that are consistently identifiable and significant to this study (Andrefsky 1998:65). The comprehensive examination of lithic attributes allows for the interpretation of reduction strategies and trajectories based on definable characteristics. This analysis strategy involves overlapping data sets, which allow for the identification and evaluation of re-occurring patterns in technology and technique. These data sets, when viewed in a broad interpretive sense, are critical to establishing parameters for understanding the organization of technology (Andrefsky1998:63; Tomka 1989:137). The Laguna Plata field work preceded (April 2010) the ADCW held in May, and the laboratory analysis preceded distribution of the workshop results (Railey 2010). However, most of the attributes incorporated into the final workshop coding spreadsheets and guidelines were used for the Laguna Plata analysis, and can be, for the most part, converted into the ADCW format.

Technological organization is further grounded in raw material selection. Previous research indicates stone availability influences the type of technology and technique selected in tool production (Andrefsky 1998:40; Crabtree 1982:2). Moreover, the presence of identifiable lithic types within an assemblage can oftentimes be viewed as a diagnostic trait for a particular lithic tradition (Hester 1972). In order to address technological change through time one must first recognize variability in nomenclature exists in the field of lithic analysis. Therefore, more than one set of analytic methods exists for examining lithic artifacts (Andrefsky 1998:62; Kooyman 2002:46). Ambiguity can be minimized, however, through the establishment of a standardized set of techniques and definitions that facilitate the analysis (Andrefsky 1998:85). Standardization allows for analytical replication and consistency in interpretation. The nomenclature adopted for this project draws heavily from the works of Andrefsky (1998) and Crabtree (1982).

Table 12.1 Assemblage composition for LA 5148 LCAS collection (1971)

Artifact Type	Artifact Number	Frequency (%)
Projectile Point	73	0.78
Biface	21	0.23
Utilized Debitage (informal)	26	0.28
Retouched Debitage (formal)	47	0.52
Mano	1	0.01
Metate	4	0.04
Cores/Tested Cobbles	40	0.44
Lithic Debitage	1,127	12.51
Hammerstone	12	0.12

** Assemblage data does not include artifacts recovered during the TRC test excavations or site survey (n=32).

Lithic debitage refers to all pieces of stone that are the byproducts of flaked-stone manufacturing or maintenance (Andrefsky 1998; Crabtree 1982; Odell 2004). The classification system selected for the analysis used a selection of both metric and non-metric attributes into which debitage from the LCAS C-10-C artifact collection was subdivided into classes. The lithic debitage assemblage was classified into four type categories that established the baseline for the subsequent analyses: 1) complete flakes, 2) proximal-flake fragments, 3) limited attribute flake fragments, limited information lithic fragments, and angular debris, and 4) modified flakes or flake fragments (Figure 12.1).

Complete flakes are unbroken flakes that retain a platform remnant, bulb of force, and identifiable termination. Proximal-flake fragments are flake fragments that retain a platform remnant and bulb of force, but are missing evidence for flake termination. Limited attribute flake fragments (LAFF), limited information lithic fragments (LILF), and angular debris include indeterminate lithic material, as well as medial and distal flake fragments. This lithic category was created as a comprehensive class into which debitage not selected for analyses extending beyond material type could be placed. Modification referred to visual identifiable damage or rejuvenation along the margins of a piece of angular debris, flake fragment, or complete fragment. Modification includes battering or edge flaking tentatively indicating use-wear and tool function.

Dorsal surface attributes include dorsal-flake scar count and percentage of dorsal cortex. Dorsal-flake scar analysis examined the number of observable flake scars on the dorsal surface. These flake scars represent previous flake removals prior to the specimen detachment (Andrefsky 1998:106; Crabtree 1982:14). The number of dorsal flake scars increases as the reduction sequence progresses (Mauldin and Amick 1989:73; Tomka 1989:143). The number of flake scars on the dorsal surface of the specimen act as a proxy measure to identifying the reduction sequence.

Reduction sequence was monitored using the triple cortex typology that classified complete debitage as primary, secondary, or tertiary depending on the percentage of remaining dorsal cortex (Andrefsky 1998:111). There is subjectivity in this approach. However, if a reduction stage is an arbitrary unit of scale that standardizes attempts to quantify technology, then some effort to empirical understanding of human behavior can be attempted (Andrefsky 1998; Magne and Pokotylo 1981; Shott 1994, 2003).

Ventral surface analysis consisted of attributes including the presence or absence of the eraillure flake, bulbar definition, and the presence/absence of platform-remnant lipping. The presence of an eraillure flake on the ventral surface of a flake may provide information on the amount of applied force used during flake initiation (Faulkner 1972:159; Odell 2004:55). Light or moderate force may leave a minimal negative flake scar or no scar at all. A large eraillure flake may indicate a high degree of applied force. These observations can be relevant to the interpretation of reduction technique, with hard-hammer percussion generally equated with intense force when applied to flake dynamics. A hard hammer swung with force may produce a large eraillure flake. A softer hammer, such as an antler billet swung with force, but because the billet is soft and slightly elastic, may be absorbed and then dispersed, leaving a small eraillure flake or perhaps none at all (Crabtree 1971:65; Hayden and Hutchings 1989:241).

Additional ventral surface attributes include bulbar definition and platform remnant lipping. The bulbs of applied force were defined as either salient or diffuse and served as an indicator of reduction technology. The assumption being that soft-hammer percussion results in a diffuse bulb of force, while hard-hammer percussion produces a well-defined, prominent bulb of force (Andrefsky 1998:115; Cotterell and Kamminga 1987:679; Crabtree 1982:74; Odell 2004:59). Platform remnant lipping was also analyzed. Based on research by Crabtree (1982:41) and Hayden and Kamminga (1989:240), platform remnant lipping may be more prevalent on flakes detached through soft hammer or billet reduction techniques. The paired attribute analysis of bulbar definition and platform remnant lipping was correlated as an estimate for determining reduction technology.

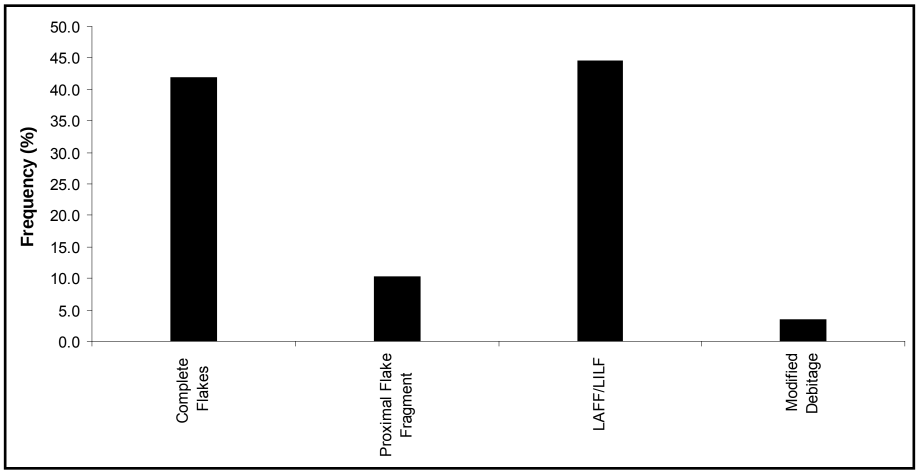

Figure 12.1 Class distribution for LA 5148 LCAS C-10-C debitage assemblage (n=1,127)

Analysis of the platform remnant also included several attributes that allowed for inferential statements on lithic technology. The platform remnant is the segment of the flake or flake fragment that retains a portion of the surface or original platform of the objective piece. This attribute allows examining platform preparation on the objective piece, or core. Additionally, platform remnant analysis provided a method for investigating raw materials selection, reduction strategies, and possibly the energy expended in tool manufacture (Wenzel 1998:79).

Five remnant categories were selected: cortical, when the platform remnant retains a portion of the outer cortex; unifaceted, referring to a platform remnant that exhibits a smooth, non-cortical flat surface (Andrefsky 1998:94). A multifaceted platform remnant is a platform remnant that contains multiple facets or flake scars along the platform. An abraded/battered platform remnant is similar to a multifaceted platform remnant, but is characterized by additional smoothing or abrasion. Abrading allowed for platform preparation by removing the overhang at the platform remnant and dorsal surface juncture. Removal of the overhang strengthened the platform remnant, preventing platform collapse with subsequent flake removals. A collapsed/crushed platform remnant commonly results from insufficient platform preparation, resulting in the crushing of the core platform rather than the successful flake detachment. Analysis of platform remnants also included platform width and thickness. Measurement of these two attributes allows for developing inferences about core size and reduction technique (Andrefsky 1998:92; Kooyman 2002:79).

The metric attributes of length, width, thickness, and weight were recorded on individual pieces of debitage. Length was measured along the proximal–distal edge on the ventral surface of the flake. A measurement was taken from the point of force application to the extreme opposite end (Shelley 1993:664). Width was measured along the widest point perpendicular to the length axis. Thickness was measured from dorsal surface to ventral surface, below the bulb of applied force. Platform remnant width was measured from right remnant margin to left remnant margin. Platform remnant thickness measured the maximum dimensions perpendicular to the platform remnant width, from dorsal surface to ventral surface (Collins 1999b:86; Shelley 1993:664). Measurements were recorded using Mitutoyo Digital Calipers accurate to 0.01 mm. Weight was recorded to the nearest tenth of a gram using an Ohaus electronic balance. A stereoscopic microscope was used for the lithic analysis.

The lithic data presented below are from the LCAS excavations of C-10-C at LA 5148. The LCAS excavation yielded 1,127 pieces of debitage that were divided into three categories. The debitage was classified as proximal flake fragments (n=123), unbroken flakes (n=490, and LILF/LAFF/angular debitage (n=518). Complete flakes were measured for length and dorsal cortex, and proximal flake fragments were included with complete flakes for platform remnant analyses.

Of the 490 complete flakes, 50.20 percent (n=246) were classified as tertiary and had no dorsal cortex. One hundred eleven flakes (22.60 percent) had less than 50 percent dorsal cortex and were tentatively viewed as occurring earlier in the reduction sequence than the removal of tertiary flakes. One hundred thirty three flakes (27.14 percent) had greater than 50 percent cortex on their dorsal surface. Collectively, 49.74 percent (244) of the flake assemblage exhibited dorsal cortex, suggesting a range of reduction trajectories at this locus. These findings reflect a tentative interpretation due to the limited number of cortex-bearing flakes in comparison to the greater number of flakes without cortex that may be produced during core reduction. The reduction sequence represented by the assemblage appears equally positioned along the reduction trajectory than would be expected for assemblages farther from the raw material source.

Following Ahler (1989) and Andrefsky (1998), whose research identified a possible relationship between reduction techniques and flake size distribution, this analysis examined several flake dimensions. The metric analysis yielded a mean maximum length of 20.18 mm, a mean maximum width of 20.34 mm, a mean maximum thickness 5.98 mm, a mean maximum thickness away from the bulb of force of 5.44 mm, and a mean weight of 3.01 grams (Table 12.2). Figure 12.2 is a box plot graph showing metric variation within the flake assemblage. The flake assemblage was further subdivided into six arbitrary 10 mm intervals to evaluate the distribution of flake size. Class I represented all flakes between 0 and 9.99 mm (n=27/5.51 percent). Class II includes 242 flakes (49.38 percent) between 10 and 19.99 mm. Class III includes flakes (n=163/33.26 percent) that measure between 20.0 and 29.99 mm in size. Frequencies of 10.40 percent (n=51) are observed for Class IV (30 to 39.99 mm), 1.02 percent (n=5) for Class V (40 to 49.99 mm), and 0.40 percent (n=2) for Class VI (50 to 60 mm). This distribution demonstrates most of the flakes collected from C-10-C are less than 30 mm in maximum length, with the greater part of the assemblage measuring between 10 and 19.99 mm. The low proportion of flakes that exceed 29.99 mm is also of interest and may relate to the original size of the cores.

Table 12.2 Summary data for metric analysis of complete flakes (n=490)

Analysis	Maximum Length (mm)	Maximum Width (mm)	Maximum Thickness (mm)	Maximum Thickness at Midpoint (mm)	Weight (g)
Mean	20.18	20.34	5.98	5.44	3.01
Sd	7.54	7	2.77	2.63	4.78

Width measurements varied from 6.15 to 49.85 mm with 52.65 percent (n=258) of the assemblage between 10 and 19.99 mm in maximum width. One-hundred eighty one (n=36.93 percent) flakes were between 20.0 and 29.99 mm in maximum width. The remaining size variations comprise 10.42 percent (n=51) of the assemblage. In addition to width, two measurements for flake thickness were calculated. Maximum thickness was measured at the thickest portion of the flake, often including the bulb of force. Maximum thickness was also taken at the flake midpoint, avoiding the influence of the bulb of force. The Student t-Test was calculated to determine if the two mean sample measurements could be derived from the same population. The confidence level was set at 0.05 with the 978 Degrees of Freedom (n-2). The two-tailed analysis returned a t-value of 3.12 and a p-value of 0.00, indicating a significant difference in the mean values for the two thickness sample groups. As the midpoint values are not affected by the bulb of force, these measurements may provide a more accurate assessment of flake thickness.

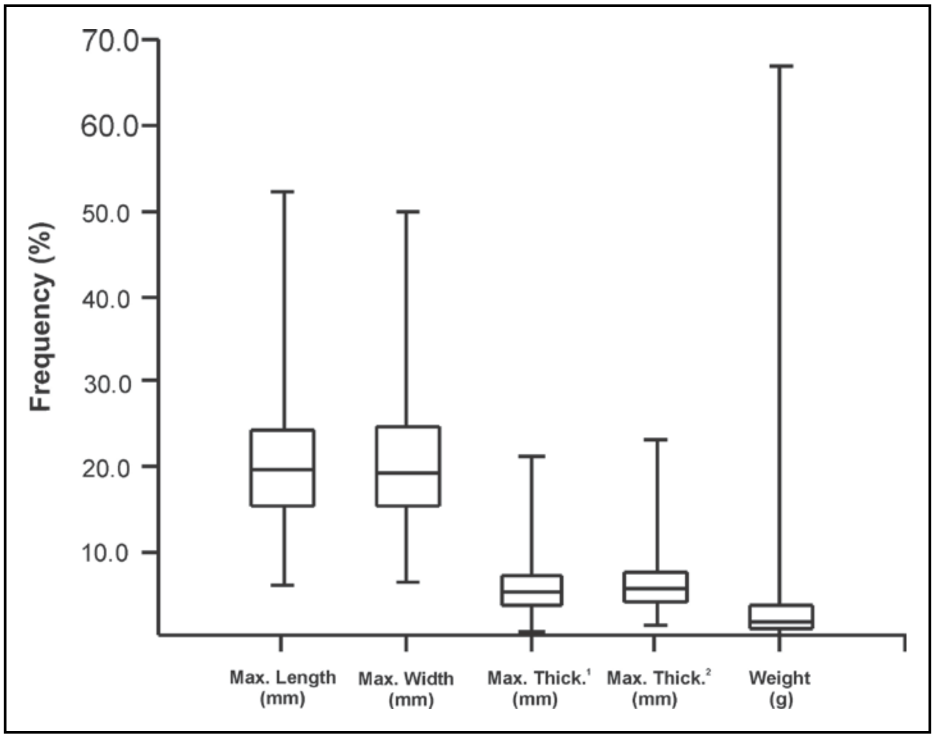

Figure 12.2 Box plot graph showing variation in flake length, width, thickness, and weight

(maximum thickness at midpoint 1; maximum thickness 2)

Weight was measured in grams and calculated for the 490 flakes. Five weight categories were recorded for the 490 complete flakes that included Class I: 0.0 to 4.99 g, Class II: 5.0 to 9.99 g, Class III: 10.0 to 14.99 g, Class IV: 15.0 to 19.99 g, and Class V: 20.0 to 29.99 g. Most of the flakes (83.46 percent/n=409) weighed 0 to 4.99 g, which correlates with a small size parameter (< 2.0 cm). Only 61 (12.44 percent) of the 490 flakes were 5 to 9.99 grams. Eleven (2.24 percent) flakes were 10 to 14.99 g, three were 15 to 19.99 g, and six (1.22 percent) were 20 to 29.99 g. Minimal variation in weight indicates little diversity in the size of the cores or the flakes being produced during the reduction sequence.

Platform-remnant analysis provided a nonparametric scale for measuring the reduction sequence for 509 complete flakes and proximal flake fragments. As the reduction sequence advances, platform length and width should conversely decrease. This approach is best applied to a bifacial reduction strategy, but can be used to analyze lithic debitage where edge maintenance is suspected. Mean average platform depth is 4.24 mm with a standard deviation of 2.57 mm. Mean average platform length is 18.17 mm with a low standard deviation of 7.96 mm.

Striking platform remnant analyses of 610 flakes and proximal flake fragments also focused on remnant type, which consisted of six classes: 1) cortical, 2) unifaceted/flat, 3) abraded/battered, 4) collapsed/crushed, 5) multifaceted, and 6) curved. As expected, platforms reflecting early reduction sequences, such as cortical (25.73 percent/n=157) and unifaceted/flat (38.52 percent/n=235), are the predominant remnant type. Collectively, these two platform types comprise 64.25 percent (n=392) of the flakes and proximal flake fragments. Collapsed/crushed platform types comprise 15.73 percent (n=96) of the assemblage, and suggest minimal core preparation prior to flake removal. Multifaceted platform remnants reflect advanced reduction sequences and are often associated with biface technology. Of the 610 specimens analyzed, only 9.34 percent (n=57) exhibited multiple facets. Curved platforms are associated with soft hammer or pressure flaking and are related to biface reduction. Nineteen specimens (3.11 percent) possessed curved platform remnants.

Eraillure flake and platform lipping presence or absence were analyzed using the combined flake and proximal flake fragment assemblage (n=610). Platform lipping, which occurs at the platform remnant and ventral surface juncture is tentatively associated with soft hammer percussion or pressure flaking. Both of these techniques are often linked to biface reduction and the manufacture and maintenance of bifacial tools. Platform lipping was identified in only 13.93 percent (n=85) of the analyzed assemblage, suggesting the use of soft hammer percussion or pressure flaking may not have been common. The presence of an eraillure flake on the ventral surface of a flake or proximal flake fragment is tentatively associated to a high application load. Application load refers to the amount of force applied in the detachment of a flake. Higher application loads are more likely to remove an eraillure flake. Eraillure flakes are commonly associated with hard hammer percussion since this technique tends to produce greater force than soft hammer percussion. Of the 610 specimens analyzed, 26.06 percent (n=159) had eraillure flake scars. This stands in contrast to the results of platform lipping, which points toward hard hammer percussion rather than soft hammer. One interpretation suggests the size of the raw material may not require elevated levels of force to remove a flake from the core. While the absence of an eraillure flake does not necessarily suggest the use of soft hammer percussion, or a biface-manufacturing trajectory, it does indicate a variety of reduction techniques may have been performed.

Bulbar definition was monitored to evaluate the application load concept. Hard hammer percussion tends to result in pronounced bulbs of force. Due to the displacement of force, soft hammer percussion often produces a diffuse bulb of force. Three subjective categories were created to evaluate this lithic attribute: 1) weak, 2) moderate, and 3) strong. Weak and moderate categories comprise 48.19 percent (n=294) and 34.09 percent (n=208) of the assemblage, respectively. Strong or salient bulbs of force were recorded in 17.70 percent (n=108) of the assemblage. These data indicate low to moderate application load, suggesting flake initiation and detachment did not require high amounts of energy.

The debitage assemblage points toward the use of both hard and soft hammer techniques. Therefore, stone conservation and tool maintenance may not play major roles in the structure of technological organization at C-10-C. With regard to the contingency table presented in Andrefsky (1998), the debitage assemblage does not appear to occur fully within one of the four categories. As noted by Miller (2007), Condon et al. (2009, 2010a, 2010b), and more recently by Railey (2010), reduction techniques utilized during the Late Archaic and Formative periods appear to fall between a formal-biface oriented reduction strategy and one that is best described as an informal core/flake trajectory. Material conservation does not seem to play a major role in tool maintenance at the site.

12.1.1 Core and Tested Cobble Analysis

Forty cores/tested cobbles were analyzed from the LCAS C-10-C collection. Cores are defined as nuclei from which flakes of varying sizes have been removed (Crabtree 1982). However, cores solely used as a source for flakes or bifaces, and cores that may have been used as tools, are difficult to differentiate. For this study, artifacts were designated as cores if they exhibited multiple negative flake scars along one or more surfaces. Cores were classified under five subcategories: 1) unidirectional 2) multidirectional, 3) bifacial, 4) core tool, and 5) tested (figure 10.14). Unidirectional cores exhibit flake scars oriented in a single direction from a single platform. Multidirectional cores exhibit flake scars in a variety of directions and from multiple platforms. Bifacial cores exhibit flake scars on two surfaces emanating from a shared margin. Core tool is an ambiguous term applied to cores with modification that implies an additional function other than as a nucleus for flake production (i.e., chopper). The term tested refers to those cobbles that show evidence of initial flake detachment, but lack any further modification, preparation, or flake removal beyond one or two flake detachments.

Lithic materials are preferentially represented by chert (23.57 percent/n=23), followed by quartzite (20.0 percent/n=8). The high incidence of chert and quartzite for cores follows the patterns observed in the debitage assemblage. Remaining materials include chalcedony (15.0 percent/n=6), igneous (2.50 percent/n=1), rhyolite (2.50 percent/n=1), and silicified wood (2.50 percent/n=1). Most of the core assemblage occurs in cobble form and often retains cortex (70.0 percent/n=28). Of the 40 cores, 18 (45.0 percent) had less than 50 percent cortex, while 10 (25.0 percent) had surfaces with greater than 50 percent cortex.

Metric attributes were recorded for complete cores, excluding core fragments and exhausted cores. Length and weight findings are summarized below, with means and standard deviations for each metric category. Mean core length was 44.71 mm with a standard deviation of 11.51 mm. Mean weight was 50.70 g with a standard deviation of 72.02 g. The complete and exhausted core assemblage (n=26) was dominated by multidirectional cores (94.73 percent/n=72), with only three cores (11.53 percent) exhibiting unidirectional flake scars. In addition, four tested cobbles (15.38 percent), three core tools (11.53 percent), and one bifacial core (3.84 percent) were identified.

The core assemblage from the LCAS C-10-C reflects the debitage assemblage in that both fit the profile of expected early through late reduction of core/flake technologies. The frequent occurrence of multidirectional cores suggests a reduction strategy that is flake oriented, random, opportunistic, and in all likelihood, expedient rather than formalized. Using the mean core size and mean flake length, there is an interesting pattern that almost precludes biface-oriented reduction. As indicated in the preceding section, mean flake size was 20.18 mm with most flakes 10 to 19.99 mm (49.38 percent) in length. A ratio of 12.25 flakes per every one core, is reflected in the LCAS C-10-C assemblage. These data tentatively suggests a low intensity occupation of the knoll despite the substantial site structure of the C-10-C locus. The low flake-to-core ratio may be accounted for as expressing the sampling with the recovery of artifacts omitting smaller-sized flakes. Alternatively, the C-10-C locus may reflect an area where core reduction was not primarily practiced. As the C-10-C locus reflects substantial occupations of various time lengths during the Formative period, the low frequency of cores and tested cobbles may indicate a spatial dichotomy in tasks and activities that due to resource availability was flexible and expedient.

12.1.2 Hammerstone Analysis

The term hammerstone is a functionally biased reference that may be misleading with regard to technology. Traditionally, hammerstones have been defined as percussors, used to detach flakes from cores (Crabtree 1982). While this interpretation may be accurate in many cases, hammerstones may also be used to pulp or mash softer resources as well. Analysis of battering and other use-wear characteristics may be observed that point towards refining artifact function.

Thirteen hammerstones were identified in the LCAS C-10-C collection (Figure 12.4). All hammerstones were categorized by shape and material, as well as standard metric attributes of maximum length, width, thickness, and weight. Material types identified within the hammerstone assemblage include coarse-grained cobbles of quartzite (46.15 percent/n=6), rhyolite (15.38 percent/n=2), and chert (15.38 percent/n=2) as the preferred stone types. Chalcedony, igneous material, and granitic stone collectively comprise the remaining 23.07 percent (n=3) of the hammerstones. Most of the hammerstones were rounded or spherical in outline. This distinction may relate to the expedient selection of cobbles from the immediate vicinity, with increased roundedness also occurring with increased use. Cobbles equating to the hammerstone morphologies were available within the site and adjacent basin margin.

Metric attributes are summarized below, with means and standard deviations. Mean hammerstone length was 57.72 mm with a standard deviation of 4.44 mm. Mean width was 43.26 mm with a standard deviation of 3.32 mm. Mean thickness was 32.25 mm with a standard deviation of 2.48 mm. Mean weight was 150.57 g with a standard deviation of 11.58 g. These values indicate a hammerstone assemblage of small cobble size and low diversity.

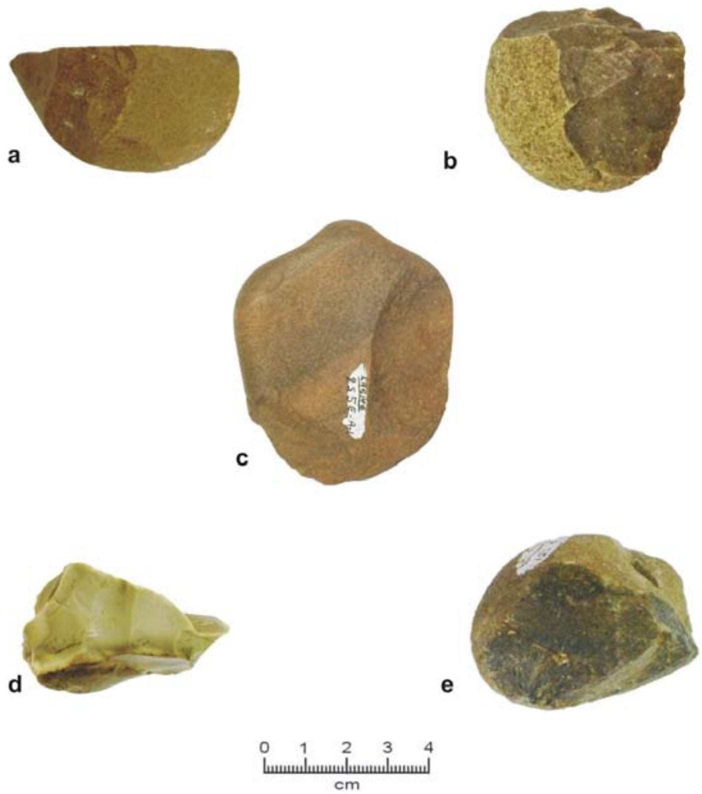

Figure 12.3 Representative cores from the LCAS collection

a) Specimen 134, unidirectional core, b) Specimen 400, multidirectional core, c) Specimen 546, tested cobble, d) Specimen 394, unidirectional core, and e) Specimen 125, bifacial core

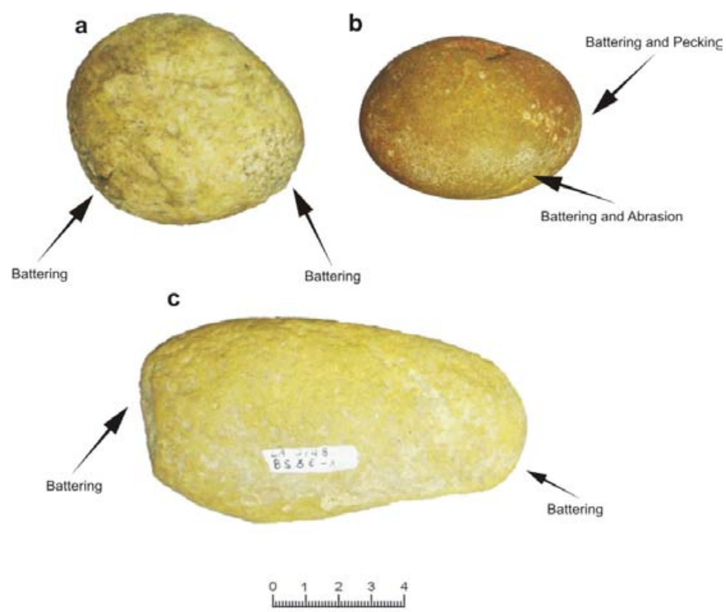

Figure 12.4 Representative hammerstones from the LCAS collection

a) Specimen 441, b) Specimen 395, and c) Specimen 131

12.1.3 Projectile Point Assemblage

All projectile points collected during the LCAS excavations at the C-10-C locus were examined in greater detail with three objectives in mind: typological or stylistic classification to provide a measure of time and associated cultural-historical associations; raw material type with regard to local and nonlocal lithic source areas; and artifact size with emphasis on distinguishing between darts and arrows. This study was selected based on Acklen et al. (1987), and more recently, Hogan's (2006) appeal towards a refinement of projectile point chronologies in the Southeastern New Mexico region. The temporal periods assigned to the projectile points are those recognized from New Mexico, Texas, and the general Southwest with estimated time durations for each type. Condon et al. (2008b), Hogan (2006:6-28), Justice (2002), MacNeish and Beckett (1987), Railey et al. (2002), Turner and Hester (1993), and Wiseman (2003) were used for references. Moreover, a correlation between typologies that are more current and Leslie's (1979) regional classification system was attempted in an effort to make use of Leslie's (1979) local research.

Prior to classification, it is important to understand that variability exists in any typological system, which is created through the selection of diagnostic attributes, in an effort to address a particular research question (i.e., identifying cultural components and site occupation). As such, attributes are not inherent, but chosen by a researcher (Andrefsky 1998; Deetz 1971). Attributes provide a means of simplification, or generalizing shared traits irrespective of other characteristics that may or may not contribute to assigning an artifact to a particular class or type. This is critical to understanding the classificatory system used to identify and place artifact assemblages in time and space (Schiffer 1986).

The LCAS sample includes 73 specimens complete enough for typological consideration. Twenty-seven of the 73 projectile points are illustrated in Haskell (1977), who tentatively assign a cultural historical period affiliation and raw material type. These diagnostic artifacts fall into 11 broad morphological types: 1) Ellis, 2) San Pedro, 3) Fairland, 4) Tularosa Corner-notched, 5) Shumla, 6) Livermore, 7) Ensor, 8) Scallorn, 9) Fresno, 10) Starr, and 11) Harrell (Table 12.3). In addition, a San Jose projectile point fragment recovered during the TRC survey and site update provides one variant to the total type assemblage at LA 5148. These types are discussed in detail below.

A single San Jose variant was recovered from LA 5148 during the recent TRC survey (Figure 12.5). The San Jose type consists of a triangular body, distinctive serrated lateral margins, shallow shoulders, and a short-concave-shaped stemmed base (Irwin-Williams 1973; Justice 2002:129). This projectile point was a dark-colored chert. San Jose projectile points date between 4500/3500 and 1500 B.C. (Justice 2002:129).

The Ellis fragment (Specimen 584) was recovered from the surface during the LCAS survey at LA 5148 (Haskell 1977). This chert fragment is fractured in a longitudinal fashion, resulting in one-half of a complete projectile point (Haskell 1977:165, Figure B). The blade portion exhibits a convex outline with overlapping flake-scars along the single lateral margin. A moderately deep corner-notch resulted in a well-defined shoulder with a slight barb or tang. The corner notching produced a short, expanding stem that is convex along the basal margin.

Table 12.3 Temporal and cultural affiliation for the diagnostic projectile point assemblage

	Specimen No.	Artifact Type	Type Correlate (Leslie 1979)	Temporal Parameters	Cultural/Historic Unit (Katz and Katz 1993)	Reference
LCAS: C-10-C						
	584	Ellis		2000 B.C. to A.D. 700	Archaic I-IV, Formative I	Haskell el al. 1977; Turner and Hester 1993

	Specimen No.	Artifact Type	Type Correlate (Leslie 1979)	Temporal Parameters	Cultural/Historic Unit (Katz and Katz 1993)	Reference
	426, 430, 447, 592, 557-2, 587, 597, 598, 593, 600, 618, 632-1, 632-4,	San Pedro	Leslie 5A, 5B, 6A	1500/1000 B.C. to A.D. 300/1000	Archaic IV, Formative I-III	Haskell et al. 1977; Carmichael 1986; Turner and Hester 1993; Condon et al. 2008
	591	Fairland		200 B.C. to A.D. 600	Archaic IV, Formative I	Haskell el al. 1977; Turner and Hester 1993
	583, 632-2, 632-3, 416	Tularosa Corner-Notched	Leslie 5A, 5B, 6A	100 B.C. to A.D. 700/900	Archaic IV, Formative I-II	Haskell et al. 1977; Justice 2002
	417, 577-1	Shumla		1000 to 200 B.C.	Archaic IV, Formative I-II	Turner and Hester 1993
	501, 577-3, 621, 630,	Livermore	Leslie 3E, 3F	A.D 100 to 800/1000/1200	Archaic IV, Formative I-V	Haskell el al. 1977; Justice 2002
	589, 614	Ensor		A.D. 500 to 1000	Formative I-III	Haskell el al. 1977; Turner and Hester 1993
	588, 592, 605, 615, 624, 629	Scallorn	Leslie 2A, 3C, 3D	A.D. 500 to 1200	Formative I-V	Haskell el al. 1977; Turner and Hester 1993; Railey et al. 2002
	607, 585	Starr		A.D. 900 to 1800	Formative II-VII	Haskell et al. 1977; Turner and Hester 1993
	299, 446, 609, 619, 620-1, 620-2, 623, 627, 634	Fresno	Leslie 1B, 1C	A.D. 800 to 1800	Formative II-VII	Haskell el al. 1977; Turner and Hester 1993; Railey et al. 2002
	599, 588, 590, 591, 594, 610, 611, 617, 622, 631	Harrell	Leslie 2B, 2C	A.D. 1150 to 1300/1500	Formative V-VII	Haskell el al. 1977; Turner and Hester 1993; Justice 2002; Railey et al. 2002
TRC Survey						
	723	San Jose		4500/3500 to 1500 B.C.	Archaic I-II	Carmichael 1986
	697, 719, 721	San Pedro	Leslie 5A, 5B, 6A	1500/1000 B.C. to A.D. 300/1000	Archaic IV, Formative I-III	Haskell et al. 1977; Carmichael 1986; Turner and Hester 1993; Justice 2002; Condon et al. 2008
	722	Starr		A.D. 900 to 1800	Formative II-VII	Haskell et al. 1977; Turner and Hester 1993
	93	Fresno	Leslie 1B, 1C	A.D. 800 to 1800	Formative II-VII	Haskell el al. 1977; Turner and Hester 1993; Railey et al. 2002; Justice 2002

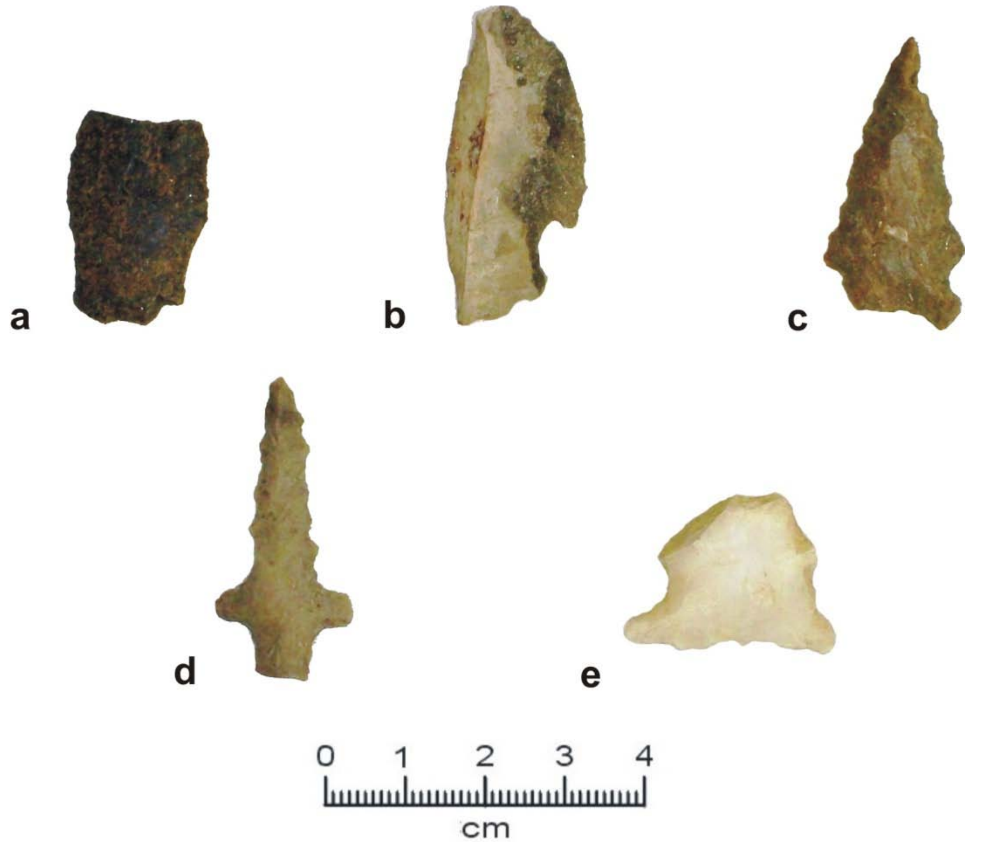

Figure 12.5 Representative projectile points collected from LA 5148

a) Specimen 166-San Jose variant, b) Specimen 584-Ellis Variant, c) Specimen 591-Fairland type, d) Specimen 630-Livermore variant, and e) Specimen 614-possible Ensor variant

The Ellis type projectile point is similar in form to the Hueco/Hatch of MacNeish (1993), Carmichael's (1986) San Pedro point, and Justice's (2002) Tularosa corner notched variants (see Figure 12.6). Turner and Hester (1993:113) broadly date the Ellis type between 2000 B.C. and A.D. 700. This age range transitions between the Archaic and the early Formative period. Based on Katz and Katz (1993) the Ellis variant transcends the Archaic I through Formative I phases.

The Fairland projectile point is distinct in style, clearly deviating from the more common Ellis, Hueco, San Pedro, and Tularosa corner notched variants (see Figure 12.6). The Fairland exhibits a long triangular body, side notching close to the proximal end, resulting in a relatively short flaring hafting element (Turner and Hester 1993:117). The base of the point is concave with a deep curvature. These characteristic also resemble the Ensor variant, a transitional Archaic-early Formative period point, of which two are present in the LCAS collection. Specimen 5911 is the only sample of the Fairland type identified in the LCAS collection (Haskell 1977:160, Figure B). Turner and Hester (1993:117) identify the Fairland type, but decline to provide an age range, only indicating this point is affiliated with the Transitional Archaic. The similar Ensor variant is dated between 200 B.C. and A.D. 600 (Turner and Hester 1993:114). It should be noted that MacNeish's (1993:171) Todsen point from Todsen Cave is similar in form, but dates to the early/middle Archaic (3500 to 2000 B.C.) (MacNeish 1993:172).

Four specimens (Specimens 501, 5573, 621, and 630) within the LCAS assemblage were typed as Livermore variants (Haskell 1977:161, Figure I). The Livermore projectile point presents a characteristically identifiable type that exhibits an elongated triangular body, oftentimes serrated, with well-defined shoulders that result from deep corner notching (see Figure 12.6). The shoulders tend to form barbs or tangs. The narrow hafting element separates the shoulders from a short expanding stem that is also concave along the basal margin (Justice 2002:231). This point type is morphologically correlated with Leslie's (1979) Type 3E and 3F variants. Regionally, Acklen et al. (1987, cf. Railey et al. 2009:189) date the Livermore type between A.D. 100 and 1100. Justice (2002:231) associates the Livermore point type to the Guadalupe Mountains of New Mexico and provides an age range of A.D. 100 to 800. Based on Katz and Katz's (1993) chronology, the Livermore point spans the Archaic IV through the Archaic II phases.

Ensor projectile points are a regionally described type that includes side notched points with short stems, straight, concave, and convex basal margins, and triangular bodies (see Figure 12.6). Ensors appear similar to Ellis and San Pedro styles and are often difficult to differentiate from the other points. Specimen 584 is the only projectile point that was typed as a possible Ensor, although Haskell (1977:165, Figure E) typed Specimen 583 as a possible Enso variant. Specimen 583 has been retyped as a Tularosa Corner Notched. In a similar fashion to Ellis, San Pedro, and Tularosa Corner Notched, Ensor points correlate with Leslie's (1979) 3A, 3B, and 5A types. Turner and Hester (1993:114) provide an age estimate of 200 B.C. to A.D. 600, which is subsumed within Katz and Katz's (1993) Archaic III and IV, and Formative I phases.

San Pedro variants traditionally coincide with the Late Archaic period, extending into the early Formative period (Carmichael 1986; Condon et al. 2008b). Thirteen (n=13) projectile point and projectile point fragments were classified as San Pedro variants (Figure 12.7). In addition, three possible San Pedro variants (Specimen 34, 62, and 159) were collected during the TRC survey. In similar fashion to Hueco and Tularosa corner-notched point forms, this type exhibits a triangular body, expanding stem, and well formed shoulders. Documented at Todsen Cave, MacNeish (1993:185) dates this form between 1000 B.C. and A.D. 1000 for the Jornada Mogollon region. Justice (2002:202) dates the San Pedro cluster, which includes locally recognized morphologically similar forms such as Marcos, Williams, and Palmillas, between 1500/1000 B.C. and A.D. 300. Along the Organ Mountain range in Doña Ana County, Condon et al. (2008b) correlated San Pedro points with radiocarbon dates from features excavated at LA 97941 and LA 97945. One San Pedro variant (Specimen 97941.724-3) was recovered from Feature 2B at LA 97941, a small hearth that yielded a conventional age of 890±40 B.P. and a calibrated age range A.D. 1000 to 1250 (Beta 247775) (Condon et al 2008:113). An additional San Pedro variant (Specimen 97945.610-2) was also recovered from Feature 3, a pit house excavated at LA 97945. Two radiocarbon samples were collected from Feature 3 resulting in a conventional age of 1290±20 B.P. and a calibrated age range of A.D. 650 to 800 (PRI-08-97-534) and a conventional age of 1110±40 B.P. with a calibrated age range of A.D. 750 to 1000 (Beta 228954), respectively. Thus, as recognized by MacNeish (1993) and furthered in Condon et al. (2008b), the San Pedro point type may continue well into the Formative period. Based on Katz and Katz's (1993) chronology, the San Pedro variant transcends the Archaic IV through Formative III phases.

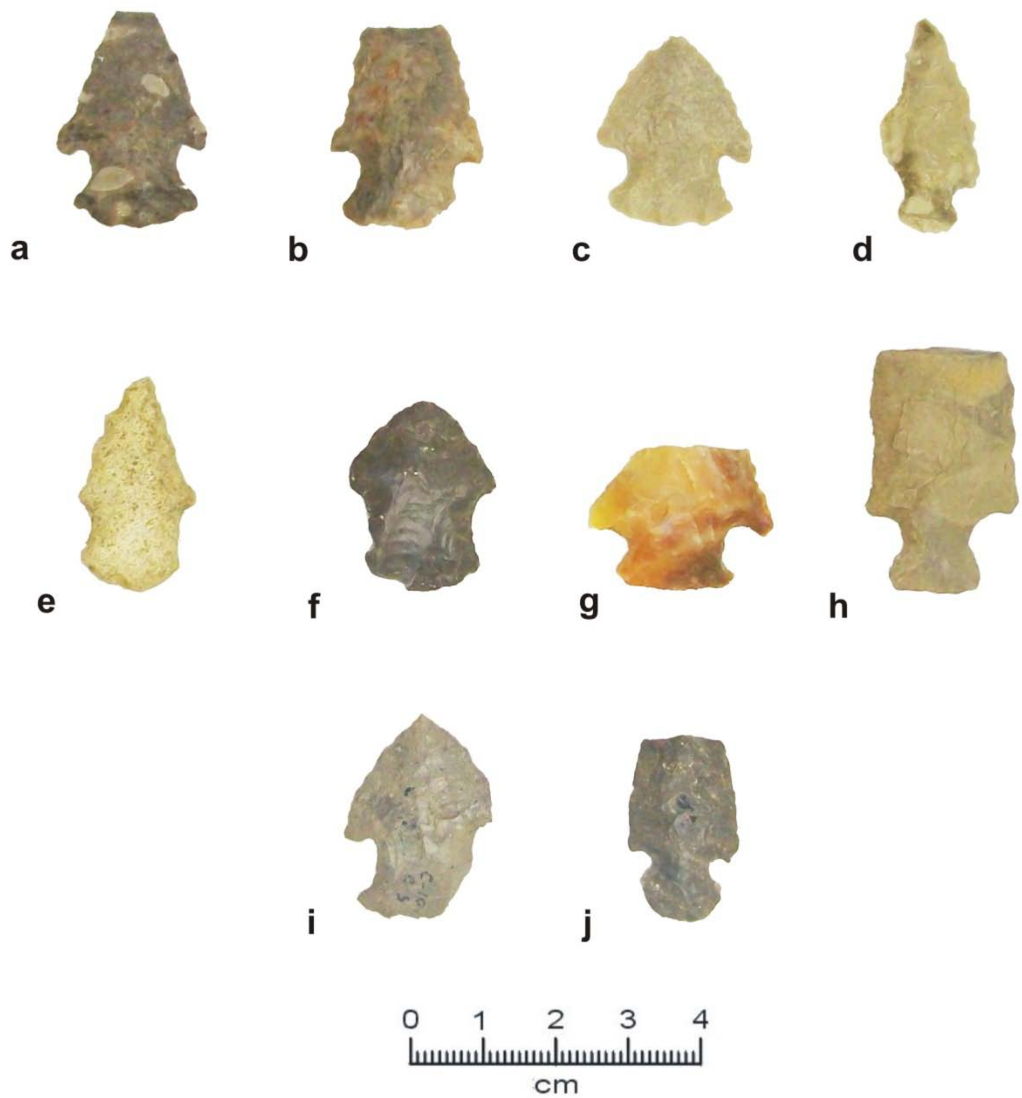

Figure 12.6 Representative late Archaic-early Formative projectile point types

a) Specimen 632-San Pedro variant, b) Specimen 618-San Pedro variant, c) Specimen 34-San Pedro variant, d) Specimen 593-San Pedro variant, e) Specimen 587-San Pedro variant, f) Specimen 632-San Pedro variant, h) Specimen 577-San Pedro variant, i) Specimen 416-Tularosa Corner-Notched, and j) Specimen 632-Tularosa Corner-Notched

Four projectile points were classified as Tularosa-Corner Notched variants as described by Justice (2002:117). This point type closely resembles many San Pedro variants, in that both have an elongated triangular body, well-formed corner notches, and a short expanding, convex base (see Figure 12.7). The primary difference appears to be in the width of the stem (Justice 2002:216). Dick (1965:83, cf. from Justice 2002:223) indicates Tularosa Corner Notched points occur in low number with San Pedro points and were treated as a small variety of the San Pedro type. Justice (2002:217) dates the Tularosa Corner Notched point between 100 B.C. and A.D. 700/900. This age range falls within the accepted parameters of the San Pedro type, from which Justice (2002:217) alludes that the Tularosa Corner Notched may be a derivative of the San Pedro type. Subsequently, it is worth asking whether the Tularosa Corner Notched point is only a regional variant of the San Pedro form and not a stand-alone point type as currently suggested. Based on Katz and Katz's (1993) chronology, the Tularosa Corner Notched point transcends the Archaic IV through Formative II phases.

Specimens 417 and 5571 were identified as Shumla-type projectile points. These types exhibit a triangular body, straight to convex lateral margins, and corner notching that produce well-defined shoulders, and a small tang or barb. Corner notching results in a short, straight stem, which distinguishes this from other similar types in the region. Cunnar (1997:61, cf. Railey et al. 2009:190) identified a Shumla type variant within the assemblage collected from LA 113045. Wiseman (2002:50, Figure 13-12) also identifies a possible Shumla-like point fragment at LA 68188, The Fox Place site The age range presented in Railey et al. (2009) is 1500 B.C. to A.D. 500. Turner and Hester (1993:186) in contrast, provide an age range of 1000–200 B.C. Based on Katz and Katz's (1993) chronology, the Shumla point spans the Archaic II through the Archaic IV phases.

The Scallorn point has a clear morphological correlate with the Dolores Expanding Stem cluster. This point type dates between A.D. 850 and 1000 (Justice 2002:244). Six Scallorn variants (Specimens 588, 592, 605, 615, 624, and 629) were identified in the LCAS collection (Figure 12.8). This projectile point exhibits a triangular body, slightly convex lateral margins, and a short expanding stem. Deep corner notches create well formed shoulders. Oakes (1983:33) at LA 36563, Acklen et al. (1987) at LA 54374, Montgomery (2006:25) at LA 43347, and Condon et al. (2008b) at LA 49917 have identified this late Formative point type in the Jornada Mogollon region. Turner and Hester (1993) date the Scallorn type between A.D. 700 and 1200, while Condon et al. (2008b) provide a more conservative age range of A.D. 750 to 950. Oakes (1983) suggests an age range of A.D. 500 to 1200. The Scallorn point is equated with Leslie's (1979) 3C, 3D, and possibly 3A types. Although not mentioned in Justice (2002), the ages associated with this point type, a middle range of A.D. 700 to 1000 (Formative I through IV phases) may reflect an accurate period of intense use.

Nine Fresno variants (Specimens 299, 446, 609, 619, 6201, 6202, 623, 627, and 634) were identified in the LCAS assemblage (see Figure 12.8). In addition, one possible Fresno variant (Specimen 93) was recovered during the TRC site survey. Fresno projectile points exhibit triangular, straight, or convex lateral margins, with straight-to-concave bases and overlapping flake scars along the lateral margins. Railey et al. (2009) identify at least two sites in southeastern New Mexico that contained Fresno point types: LA 33165 and LA 32623, both sites were recorded by Lord and Reynolds (1985:153). Railey et al. (2002:189) broadly date the Fresno point between A.D. 950/1000 to 1300, while (Dorshow et al. (2000) date it between A.D. 800 and 1750. Justice (2002:267) correlates the Fresno point with the Cottonwood point of the greater Southwest and identifies this projectile point as occurring after A.D. 950. Fresno points are initially affiliated with the Formative II phase and continue to be recovered from sites dating after the Formative VII phase.

Two specimens (Specimen 585 and 607) in the LCAS collection were identified as possible Starr variants by Haskell (1977:166, 167) (see Figure 12.8). One additional point fragment (Specimen 163), collected during the TRC survey was also typed as a possible Starr variant. The Starr point is a distinctly shaped triangular point with a deep concave basal margin (Turner and Hester 1993:231). Unfortunately, Starr variants are not common in the Jornada Mogollon region and only slightly more frequent in the lower Rio Grande and southeastern coastal areas of Texas. Turner and Hester (1993) date the Starr type to the late Prehistoric period, or after A.D. 1200., while Ricklis (2004:172, Figure 5.18) more recently assigns the Starr type to the late Prehistoric period dating A.D. 1000 to 1250/1300 for the coastal region of Texas.

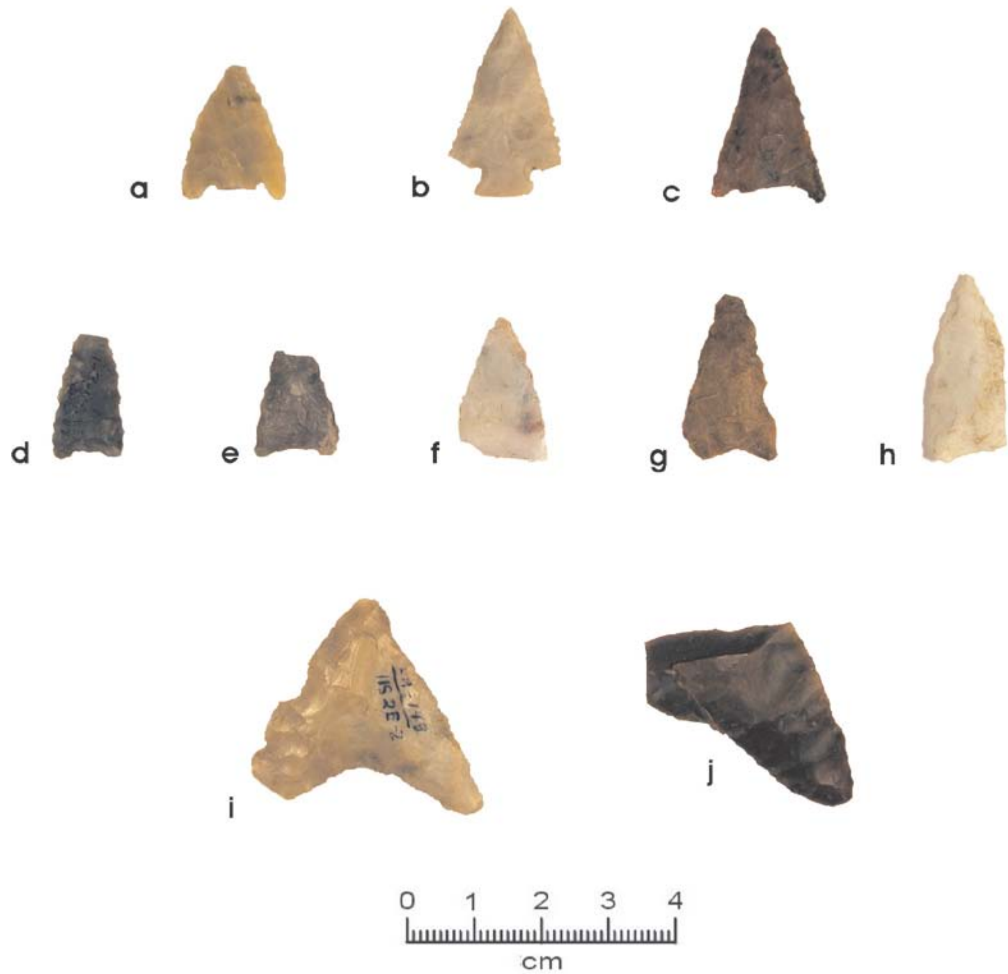

Figure 12.7 Representative middle and late Formative projectile point types recovered from LA 5148

Scallorn: a) Specimen 605, b) Specimen 615, and Specimen 629; Fresno: d) Specimen 446, e) Specimen 623, f) Specimen 620, g) Specimen 623, and h) Specimen 619; Starr: i) Specimen 585 and j) Specimen 163 (TRC survey)

Possibly transitioning from the Scallorn point is the Harrell projectile point type (Figure 12.8). This distinct and ubiquitous point type has been identified across much of the Southwest, with correlates identified in the lower Pecos region of Texas (i.e., Toyas), on the Southern High Plains (i.e., Washita point) and as far as the Mississippi River Valley (i.e., the Cahokia point). This triangular point type exhibits side notching and side notching in conjunction with a distinct basal notching. If basal notching is absent, the basal margin can be straight, slightly convex, or slightly convex (Justice 2002:289; Turner and Hester 1993:217). Identified by Leslie (1979) as 2B, 2C, and 2F Types for the Jornada Mogollon region, this type variant is clearly present at many of the late formative period sites in the region. Wiseman (2002) presents 51 Harrell/Washita points from The Fox Place site (LA 68188), while Corley and Leslie (1960) identified this point variant at the LA 32220, the Boot Hill site. Justice (2002:319) provides a correlate in the broad-based Pueblo-Side Notched cluster. Justice (2002:298) dates the occurrence of these point types, which include Washita and the Toya variant, between A.D. 1150 and 1300/1500. Wiseman (2002:159) proposes at least three potential occupational ranges at The Fox Place site from which a large number of Harrell points were collected, A.D. 1270 to 1315, A.D. 1345 to 1390, and A.D. 1410 to 1420, all of which post date A.D. 1150. Using Katz and Katz's (1993) cultural chronology, the Harrell variant occurs in the region during the Formative V through VII phases.

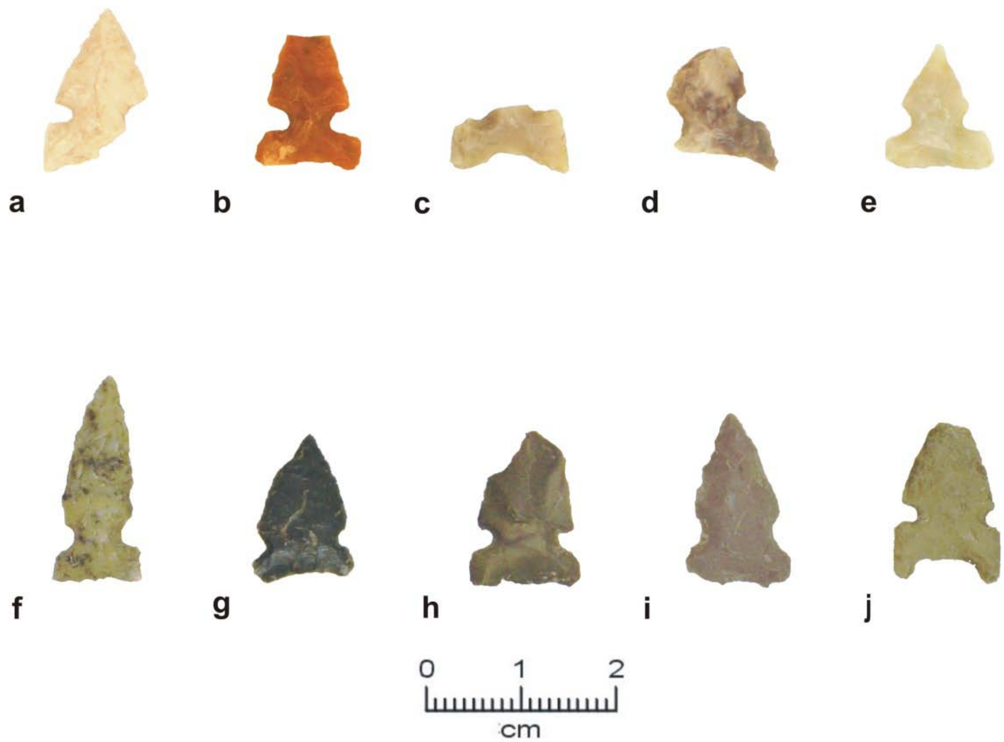

Figure 12.8 Representative late Formative projectile point types recovered from LA 5148

Harrell/Washita: a) Specimen 610, b) Specimen 611, c) Specimen 124, d) Specimen 588, e) Specimen 590, f) Specimen 622, g) Specimen 617, h) Specimen 591, i) Specimen 631, and j) Specimen 594

12.1.3.1 Metric Variability and Analysis

As demonstrated in the previous section, there appears to be a clear distinction between projectile point types that are traditionally considered dart points (e.g., San Pedro) and those identified as arrow points (e.g., Harrell). The transition between these point types is often assigned as a transitional marker prehistoric technology correlated with the size of the weapon system. However, dart points continued to be manufactured and used well into the Formative period and through continued maintenance are reduced in size. Distinguishing between the two projectile types may further our understanding about the timing and nature of this transition (Shott 1996:286).

Hogan (2006:6-28), citing Katz and Katz (1985), offers a generalized formula for segregating arrow points from dart points, and provides a proxy measure for type classification. The neck-width criteria was provided to aid in assigning hafted bifaces to a particular type and is segregated in the following manner: 1) < 9 mm is equated to the late Prehistoric arrow point, 2) 8–8.99 mm is equated with the arrow to dart transitional period, 3) 9–14.0 mm coincides with the terminal Archaic dart point, and 4) 13–16.0 mm correlates with the late Archaic period dart points. This statistical separation results in a bimodal distribution that occurs between 8 and 9 mm (Boyd 1977; Lowder 2009). Roney's (1985) research in the Guadalupe Mountains tends to support this interpretation, which suggests concave bases, contracting stems, and side notching may reflect a pre-1000 B.C. occupation, expanding stems with straight or convex bases and neck widths of less than 8 mm may occur with greater frequency after 1000 B.C. This hypothesis, when viewed broadly, does seem to hold true. However, as the taxonomic analysis demonstrates, several traits, such as side and corner notching are time transgressive in that both attributes can be found on projectile points dated to the Archaic and the late prehistoric. If form is dictated not solely by style, but by the constraints of technology, in this case the transition from darts to arrows, then a more salient shift should be expressed in the artifact data.

Following this trend, Shott (1996:286), using ethnographic data, suggests width/thickness metric parameters for arrow points rarely exceed 1 cm in width and 0.5 cm in thickness, while darts measure greater than 1 cm in neck width (Shott 1996:286). In an effort to distinguish between dart and arrow points, two sets of discriminating functions were calculated. Bradbury (1997) measured maximum point width and maximum neck width in an effort to separate dart from arrow. Shott (1996), in a modification of Thomas (1971), selected maximum length, maximum width, maximum thickness, and maximum neck width as discriminating variables that would allow for separating of darts from arrow points. Functions presented by Shott (1996) and Bradbury (1997) are discussed in length in Ames et al. (2010) and Railey (2010) and summarized below:

Shott (1996)

Dart: C=0.188 maximum length+1.25 maximum width+0.392 maximum thickness-0.223 neck width-17.552

Arrow: C=0.108 maximum length+0.47025 maximum width+0.864 maximum thickness+0.214 neck width-7.922

Bradbury (1997)

Dart: C=(1.420838 x maximum width)+(0.05398166 x neck width)

–17.31622

Arrow: C=(0.632 x maximum width)+(0.5082722 x neck width)

–7.86771

Seventy-three projectile points and point fragments from the LCAS collection and six projectile points from the TRC survey were analyzed for maximum length, maximum width, and maximum thickness, as well as for neck width values (Table 12.4). Of the 73 projectile points, 35 had a measurable neck remnants. Solving for Shott (1996) and Bradbury (1997), calculations correctly identified 21 (60.0 percent) of the 35 measurable point or point fragments. When Katz and Katz (1985) metric range for neck width is calculated, 28 (80.0 percent) of the 35 specimens were correctly identified. As argued by Lowder (2009:42), stems measuring less than 8 mm in maximum width were considered small projectile points most likely associated with the bow and arrow. Measurements between 8 and 13 mm were associated with medium-sized projectile points most likely belonging to the dart classification. Neck width greater than 13 mm were exclusively grouped as darts. As Railey et al. (2010:278) suggests, variability and resource morphology may account for discrepancies in both dart and arrow points. The general correlation points towards a possible shift from a biface oriented reduction strategy to a core-flake technology, which tends to parallel the technological change from the dart/atlatl to the bow and arrow.

Table 12.4 Metric attribute data and classification values

Artifact No.	Length (mm)	Width (mm)	Thick. (mm)	Neck Width	Dart (Shott 1996)	Arrow (Shott 1996)	Dart (Bradbury 1997)	Arrow (Bradbury 1997)
615	25.48	15.2	3.08	6.56	15.75	8.3499	16.7636	14.5038
605	21.28	15.74	3.44	5.98	8.24	8.9592	3.9964	1.6135
602	18.45	23.72	5.88	12.1	5.95	4.2669	4.9767	2.0496
592	17	16.48	5.73	7.97	4.59	5.3185	2.6608	1.0193
587	27.98	15.01	4.40	11.27	6.07	5.6740	4.5647	1.8663
593	34.59	16.57	6.26	7.75	1.32	2.0438	0.7568	0.1724
583	12.3	19.88	5.18	15.44	1.50	2.6368	-0.9340	-0.5798
416	32.65	23.42	5.70	14.89	7.20	5.0867	9.5502	10.4425
597	17.01	17.64	5.09	12.31	11.15	7.3670	9.8322	8.1273
589	12.92	17	6.04	12.73	1.03	1.5687	0.2928	2.4308
632	29.19	19.85	4.68	10.99	6.27	6.4121	3.6127	1.4428
624	10.59	14.67	4.83	7.12	2.85	2.3994	2.2629	0.8424
612	41.41	23.51	6.31	13.5	7.33	3.9214	11.7635	12.5458
447	15.95	18.41	6.30	13.13	14.13	10.5659	8.0599	3.4212
618	29.02	20.86	6.30	12.64	27.78	14.6830	27.3265	11.9922
577	29.62	18.8	5.77	8.09	5.03	3.5444	4.6189	7.3480
599	53.14	22.09	8.10	15.92	-0.61	1.1738	-2.6958	-1.3636
591	17.91	12.77	3.55	7.45	4.92	3.9577	7.5252	9.3480
617	18.16	12.77	3.01	9.16	-0.22	0.3676	0.6748	2.9688
622	25.27	11.04	3.50	5.96	0.96	1.4871	1.2300	3.9906
591	37.33	18.03	7.20	13.57	11.01	7.9006	9.0340	10.4259
610	18.28	12.32	3.47	6.67	6.00	4.9047	6.5294	6.5999
611	16.71	13.5	2.81	5.18	9.67	7.3518	6.6454	6.5450
594	18.51	12.61	2.80	8.22	0.41	0.6639	1.0443	4.2808
601	20.05	12.94	3.41	8.59	6.96	5.1459	4.8489	1.9927
598	33.2	14.48	6.12	10.46	12.65	9.8629	11.4557	4.9319

Artifact No.	Length (mm)	Width (mm)	Thick. (mm)	Neck Width	Dart (Shott 1996)	Arrow (Shott 1996)	Dart (Bradbury 1997)	Arrow (Bradbury 1997)
632	27.02	16.02	6.24	8.12	6.18	3.9693	8.4119	9.5390
631	21.55	12.83	4.27	8.65	6.23	5.5184	3.8222	6.6013
590	13.89	12.44	2.54	5.85	18.71	11.7909	14.9295	14.1866
588	15.77	10.99	3.47	6.33	6.36	4.6319	7.0447	9.2843
600	23.86	16.65	5.72	13.04	1.26	1.4332	1.5331	4.6775
614	22.87	24.68	6.00	12.25	20.48	13.6806	16.0166	6.9609
632	24.76	19.16	5.03	13.3	23.40	14.4879	19.1851	8.3704
632	19.81	16.16	5.60	11.12	5.46	3.4665	5.3706	5.1207
577	20.07	12.2	3.10	5.09	7.09	4.3622	6.4402	2.7007
630	31.85	14.9	5.47	5.63	8.18	5.0718	7.4916	3.1684
124	8.67	14.97	2.67	5.90	3.84	4.2550	-0.4367	-0.3586

The results of this analysis suggest a subtle, yet distinguishable pattern that indicates the ability to segregate dart from arrow points. However, the more critical question regarding this study focuses on the perceived shift in technology for the region as presented in Ames et al. (2010). Research by Ames et al. (2010:321) suggest that despite the presence of the bow and arrow in the Great Basin region by 2000 B.P. (ca. A.D. 50) and a primary shift to this technology by 1350 B.P. (ca. A.D. 600), that knowledge and utilization of the bow and arrow may have occurred in the early and middle Holocene. For the southeastern New Mexico region, this implication suggests the possible knowledge and utilization of multiple technologies through time, albeit on an intermittent and sporadic basis. The more acceptable age range for the shift from atlatl dart to the manufacture of arrow points in the southeastern New Mexico region is between A.D. 500 and 700 (Railey 2010:266). While Fresno, Scallorn, and Harrell types traditionally reflect arrow points, the general wide age range associated with points types prior to the late Formative period do not provide much help in narrowing down this transition in technology.

12.1.3.2 Projectile Points and Material Selection

As noted in Haskell et al (1977), most lithic raw materials at LA 5148 can be obtained in the alluvial deposits and outcrops noted in and around the site proper. Moving beyond the geographic origins of the materials is more problematic as a wide range of physical characteristics makes further interpretations other than recording general material type difficult. To circumvent this problem, the material analysis of the projectile point assemblage (n=79), combined LCAS and TRC survey data recorded material class and material description. Material type data were generated using general geologic terms (i.e., chert, chalcedony). Material description followed Wiseman (2006, cf. Hogan 2006:6-38) and provided color in addition to type. Despite the subjectivity in recording, the author's are in agreement in the value of recording descriptive text with regard to tool stone.

Six material types were identified in the projectile point assemblage. As demonstrated in Figure 12.9, outcrops of lithic types were observed in varying quantities within the site boundaries, within arroyos, or as gravels and cobbles along the alluvial fans emanating from the western margins of the playa basin. The material types were all considered local in origin, suggesting access to this tool stone was almost immediate and not originating outside the region. Of the six material types, chert (83.54 percent/n=66) is the most frequent followed by chalcedony (8.86 percent/n=7). Both of these cryptocrystalline silicates allow for a controlled fracturing and maintain a sharp edge. Igneous materials included rhyolite and comprise 3.79 percent (n=3) of the projectile point assemblage. Silicified wood (n=1), quartzite (n=1), and orthoquartzite (n=1), each comprise 1.26 percent of the point assemblage.

Seven projectile points were identified as being made from chalcedony, a cryptocrystalline variety of quartz, predominately silica, exhibiting varying degrees of translucency (Crabtree 1982:28). Chalcedony is present within the site area and occurs as small gravel and larger cobbles. Seven different colors were noted for the projectile point assemblage, with most associated with opaque-hydrated chalcedonic stone. Colors associated with chalcedony included semi-translucent red mottled with dark red, translucent white, semi-translucent light gray mottled with black inclusions, light or pale gray, gray mottled with red, and gray mottled with brown. As Figure 12.9 shows, chert (n=66) offered a broad cross section of material colors and was the most common tool stone. This fine-grained siliceous stone was readily accessible within arroyos and along fan escarpments as secondary lag deposits. Eighteen different colors or color combinations were documented for the chert projectile points. Gray mottled with brown occurred in 22.72 percent (n=15) of the projectile assemblage. This color combination was identified in both dart and arrow types and has been previously recognized by Wiseman (2002:303) in the Fox Place site (LA 68188) projectile point assemblage. The second most frequent was gray, generally a homogenous color that ranged in hue from light to dark. Light gray (3.03 percent/n=2) and dark gray (3.03 percent/n=2) was identified with same frequency. In comparison, a medium grade of gray occurred in elevated frequencies (15.15 percent/n=10). White, which ranged from dull to bright comprised 13.63 percent (n=9) of the point assemblage. Light gray/mottled dark gray occurs in 9.09 percent (n=6) of the assemblage. The remaining

12 colors individually comprised less than 5 percent of the assemblage. Of note are gradients of pink (3.03 percent/n=2), red (3.03 percent/n=2), and reddish white (1.51 percent/n=1) that may reflect thermal alteration of poorer quality tool stone.

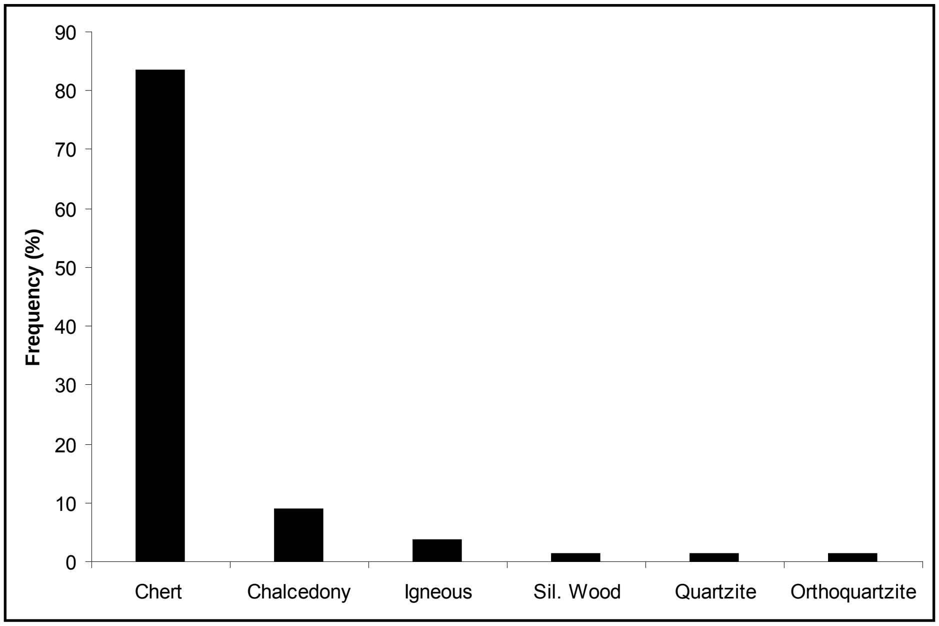

Figure 12.9 Frequency distribution of material types identified in the projectile point assemblage (n=79)

The remaining projectile points (n=6) were made from rhyolite (n=3), orthoquartzite (n=1), quartzite (n=1), and silicified wood (n=1). Rhyolite exhibited color combinations of light gray with phynocrysts, dark red mottled with brown, and reddish brown (Figure 12.10). Rhyolite was not found in abundance in or around the site locus. Orthoquartzite was a light gray, while the quartzite point was a homogenous gray. Both these material types are common at LA 5148 along the exposed playa margins in cobble form. Silicified wood is a tan hue with a texture resembling the original wood grain. Silicified wood is commonly recovered as odd-shaped nodules rather than spherical cobbles at LA 5148. The quality of the silicified wood varies, with most of the lag deposits exhibiting grainy, coarse textures.

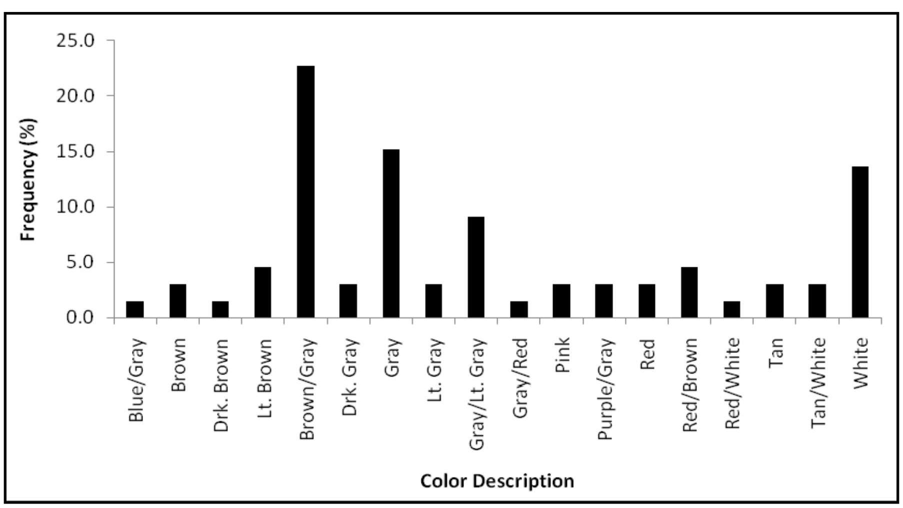

Figure 12.10 Color descriptions for chert projectile points (n=66)

12.1.4 Modified Debitage Analysis

Flaked-stone tools encompassed a range of artifact types that generally did not include hafting (i.e., projectile points) elements or tools created for longevity. The exception to this are drills, which tend to be hafted and kept in continuous rotation during the lifecycle of the artifact. In essence, flaked-stone tools include both formal and informal tools, the majority of which appear to be manufactured for short term, task specific activities. This implies that many of the stone tools identified in the LCAS collection were manufactured, utilized, and discarded at the point at which they were recovered. For this study, flaked-stone tools were examined through a series of attributes that targeted the location and extent of modification on each piece of debitage. This approach avoided weighted terms, such as side scraper or end scraper, both of which predispose the reader towards a subjective interpretation regarding function and the organization of technology.

All debitage exhibiting flake scars was considered modified. Modification was quantified as unpatterned, non-extensive nor continuous, and usually, but not always, limited to one or two margins. Observable flake scars were generally small, irregular, and limited in extent, rarely extending more than one-quarter of the width of the objective piece. Debitage that exhibited continuous retouch flake scars along one or more faces and/or margins were also placed in the modified category, with location and extent of flake scar noted (Ahler 1983; Andrefsky 1998). Modification for these tool types extended more than one-quarter past the margin of the objective piece. Recording identified number of modified margins, type of modification (i.e., unimarginal-one margin or bi-marginal-two noncontiguous margins, and bifacial), number of faces modified (i.e., unifacial or bifacial). Retouch was identified by flake scars extending beyond one-quarter of the objective piece. Raw material type was recorded for each flaked-stone tool.

Figure 12.11 shows the percentage distribution of flaked-stone tools according to modification attributes. Strong attribute differences exist between the five modification classes, suggesting a range of attributes characterize the 76 specimens identified in the LCAS assemblage. The individual modification parameters show the majority of the tool types is dominated by debitage exhibiting unifacial-unimarginal flake patterns. These two attributes indentify modification on one face and along one margin and comprise 67.10 percent (n=51) of the tool assemblage. Debitage that exhibits modification on one face, but along noncontiguous margins comprises 9.21 percent (n=7) of the tool assemblage. Bifacial modification along one margin (5.26 percent/n=4) and along two margins (2.63 percent/n=2) also occur, but in lower frequencies. Retouch flake patterning was identified in 15.78 percent (n=12) of the tool assemblage, suggesting multiple resharpening episodes and tool maintenance. Data on the combined tool assemblage yields a pattern of limited use and rejuvenation. In general, the extent of modification attributes exhibit a far greater degree of minimal use (84.22 percent/n=64) that coincides with a core/flake technology, rather than a bifacial technology. Modification along one or more noncontiguous margins occurs with the highest frequency (76.31 percent/n=58). These tools tend to show clear, but conservative evidence for modification. Retouched debitage occurs in low frequencies, which is not unexpected due to the proximity of lithic resources in the Laguna Plata area (Andrefsky 1998).

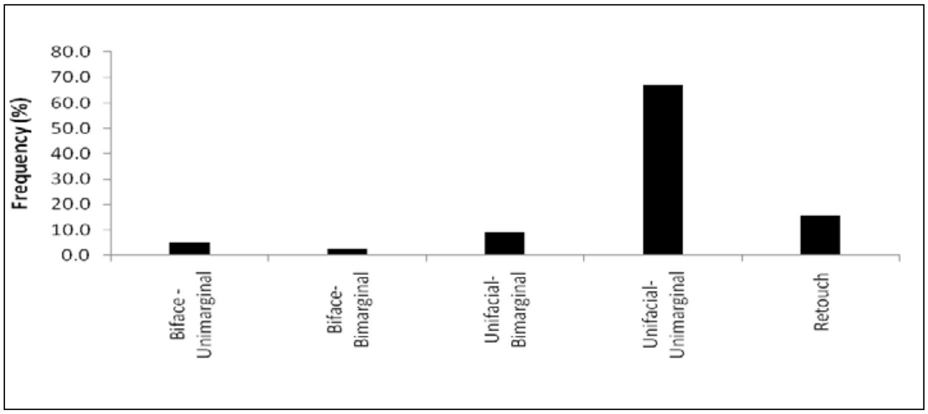

Figure 12.11 Frequency distribution for modified debitage (n=76)

Figure 12.12 shows a frequency distribution graph of the relationships between six material types and the flaked-stone tool assemblage. As shown in the debitage and projectile point analysis, chert (65.78 percent/n=50) occurs with the highest frequency in the flaked-stone tool assemblage. Interestingly, quartzite comprises 15.78 percent (n=12) of the 76 flaked-stone tools and is the second highest occurrence. The remaining material types, including chalcedony (6.57 percent/n=5), igneous (5.26 percent/n=4), silicified limestone (3.94 percent/n=3), and silicified wood (2.63 percent/n=2) comprise less than 20 percent of the assemblage.

Due to the limited spatial and contextual data assigned to the LCAS assemblage, it is not possible to assume precise contemporaneity between the analytical units within the flaked-stone tool assemblage. It is useful to point out similarities in attribute trends, marked by an emphasis on limited use tools made primarily from chert or fine-grained quartzite. An examination of the frequencies is instructive in light of Railey's (2010) focus on the relationship between mobility and expediency in tool manufacture and use. Few tools exhibit extensive flake scar patterning within the LCAS assemblage. Thus, the technological dimension shows little variation despite an assumed extended occupation at C-10-C from which many of the artifacts were recovered. The TRC survey of the remainder of the site tends to support the near absence of retouched flaked-stone tools. The general lack of retouched artifacts may be the result of local collecting over the years, resulting in a bias in the recovered assemblage. However, the easy access to lag deposits from which adequate stone tools could be manufactured, likely accounts for the general low frequency of retouched artifacts.

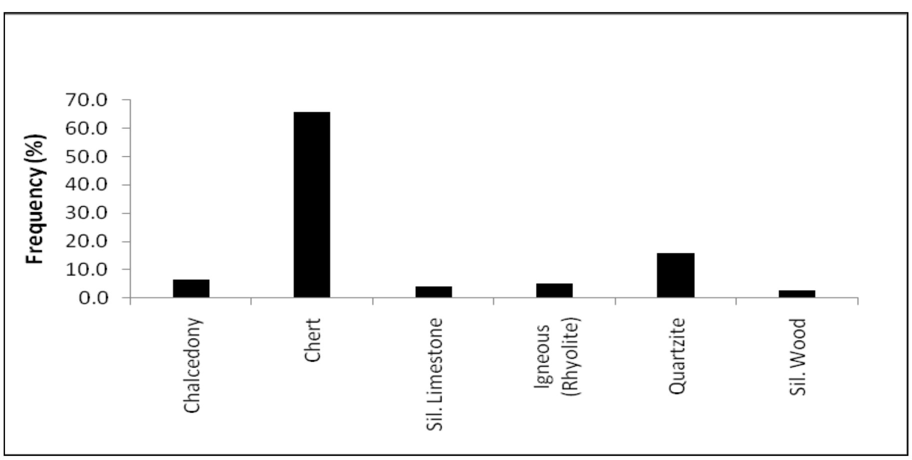

Figure 12.12 Frequency distribution for raw material occurrence in the flaked-stone tool assemblage

12.1.5 Flaked-Stone Tools: Biface Analysis

The 45 bifacial-stone implements identified in the LCAS assemblage were analyzed separately from unpatterned or retouched flaked-stone debitage. Bifaces, by definition, exhibit intentional flake patterning along two faces meeting at a shared margin. The extent of modification precluded these artifacts from inclusion into the previous discussed tool assemblage. The LCAS assemblage contained a small biface assemblage consisting of nondiagnostic projectile point fragments, biface fragments, complete bifaces, and one drill fragment (Figure 12.13). Most are projectile point fragments that comprise 33.33 percent (n=15) of the 45 artifacts. Eleven (24.44 percent) were categorized as mid-or-late stage bifaces, which exhibit extensive flake removals, shaping and thinning, but in most instances, lack evidence for a hafting element. Twelve (26.66 percent) were classified as biface fragments. There is one (4.16 percent) hafted drill fragment.

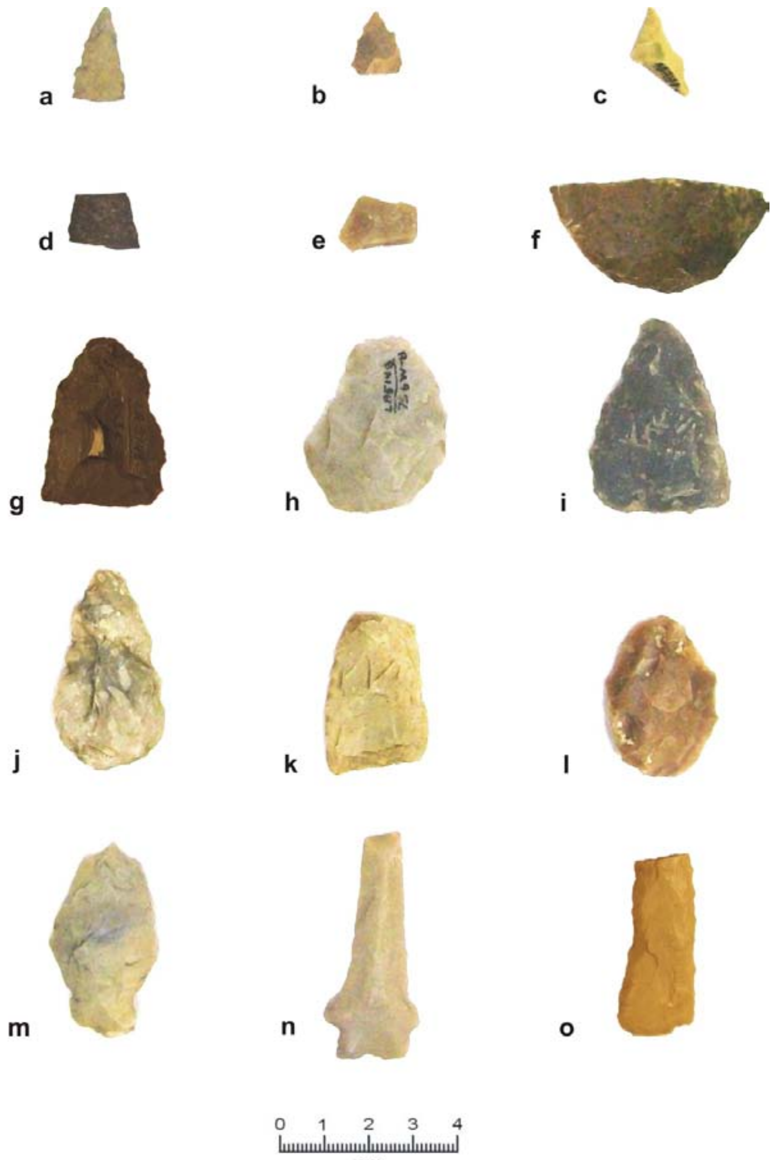

Figure 12.13 Flaked-stone tools from the LCAS collection

Projectile Point Fragments-a) Specimen 613, b) Specimen 577, and c) Specimen 422; Bifacial tools-d) Specimen 421, e) Specimen 297, and f) Specimen 606; Staged-Bifaces-g) Specimen 293, h) Specimen 474, i) Specimen 608, j) specimen 586, k) specimen 604, and i) specimen 256; Flaked-Stone Tools-task specific-m) Specimen 612 (graver), n) Specimen 599 (drill), and o) Specimen 427 (scraper)

The26 nondiagnostic projectile point fragments suggest a greater frequency of projectile point manufacture, or retooling , than what is shown in the projectile point assemblage. The 11 unbroken bifaces have bifacial reduction consisting of large flakes, with one shaped into a possible awl. Three biface fragments are indeterminate towards reduction sequence or stage. The mean length of the unbroken bifaces was 29.84 mm, with a standard deviation of 9.25 mm. Mean width was 25.72 mm, with a standard deviation of 4.87 mm. Mean thickness was 7.23 mm with a standard deviation of 2.51 mm. Average weight was 4.89 g (standard deviation 3.89 g). Specimen 599 is a hafted chert drill that is missing its distal end. Specimen 427 exhibits bifacial flake scars along the upper portion of the tool with a steeply inclined unifacial patterning along the distal and lateral margins. Similar to the preceding lithic analyses, most (91.66 percent/n=22) of the bifacial tools were made from chert. The remaining material types included quartzite (4.16 percent/n=1) and silicified wood (4.16 percent/n=1).

In reviewing the biface assemblage, two observations stand out. Over 75 percent of the artifacts classified as bifaces were broken or incomplete. These artifacts may have been in a pre-projectile or cutting tool manufacturing trajectory, but their incomplete form precludes a more definitive functional interpretation. The second observation is the mean length of the unbroken biface assemblage is less than 3 cm, suggesting a small objective piece. These bifaces, in all likelihood, reflect tools that have been roughly shaped, with irregular lateral margins and deep flake scars. While these artifacts have been thinned, they are unfinished with regard to tool thickness. Few indicate a finished biface, but one that only needs a hafting element to complete the manufacturing trajectory. The identification of specific tool forms, including a drill, an awl, and a scraper, may reveal specific activities at LA 5148. As presented in Haskell (1977), the presence of these artifact types suggest the scraping of flesh or hides, the drilling of larger items, such as bone or wood, and the more refined inscribing or perforating conducted by awls or gravers.

12.1.6 Ground Stone Analysis

Only a small percentage of the collected artifacts were ground stone implements. Artifacts identified as grinding implements were classified into four tool types. Metates and grinding slabs are usually associated with processing organic and/or inorganic materials. Slab metates are identified by use-wear patterns on a flat surface. Basin metates are usually defined by the circular grinding action resulting in a hollowed out surface. Metates recovered during TRC's testing project were manufactured from local raw materials, mainly sandstone, granitic material, and limestone available within the site area and eroding from the alluvial fans in the western portion of the playa basin. Manos are usually the hand implement used on the stationary metate. There are several types of manos, and they can be classified as one-hand or two-hand grinding tools. Their shape attributes are along the edges and have use-wear consisting of ground or polished surface(s).

Five ground stone artifacts in the LCAS collection and an additional two were collected by TRC (Figure 12.14). Of the seven items, five metate fragments and two manos or mano fragments were identified. Three different material types were present, including limestone (14.29 percent/n=1), granitic material (28.57 percent/n=2), and sandstone (57.14 percent/n=4).

To assess the variation in overall ground stone artifacts, the single mano and metate fragments were measured, including maximum length, maximum thickness, and weight (g). One complete mano was identified. The mano was 102.69 mm long, 78.54 mm thick, and weighed 324.10 g. This mano, made from limestone, exhibited modification on two surfaces, one flat and one slightly convex. Five (n=5) metate fragments were analyzed. Their mean length was 78.46 mm, with a range of 45.74–105.63 mm. Mean thickness was 24.18 mm with a range of 2.36–39.06 mm. Mean weight was 324.1 g with a range between 27.9–301.5 g. Of the seven ground stone artifacts, three (42.85 percent) were thermally altered.

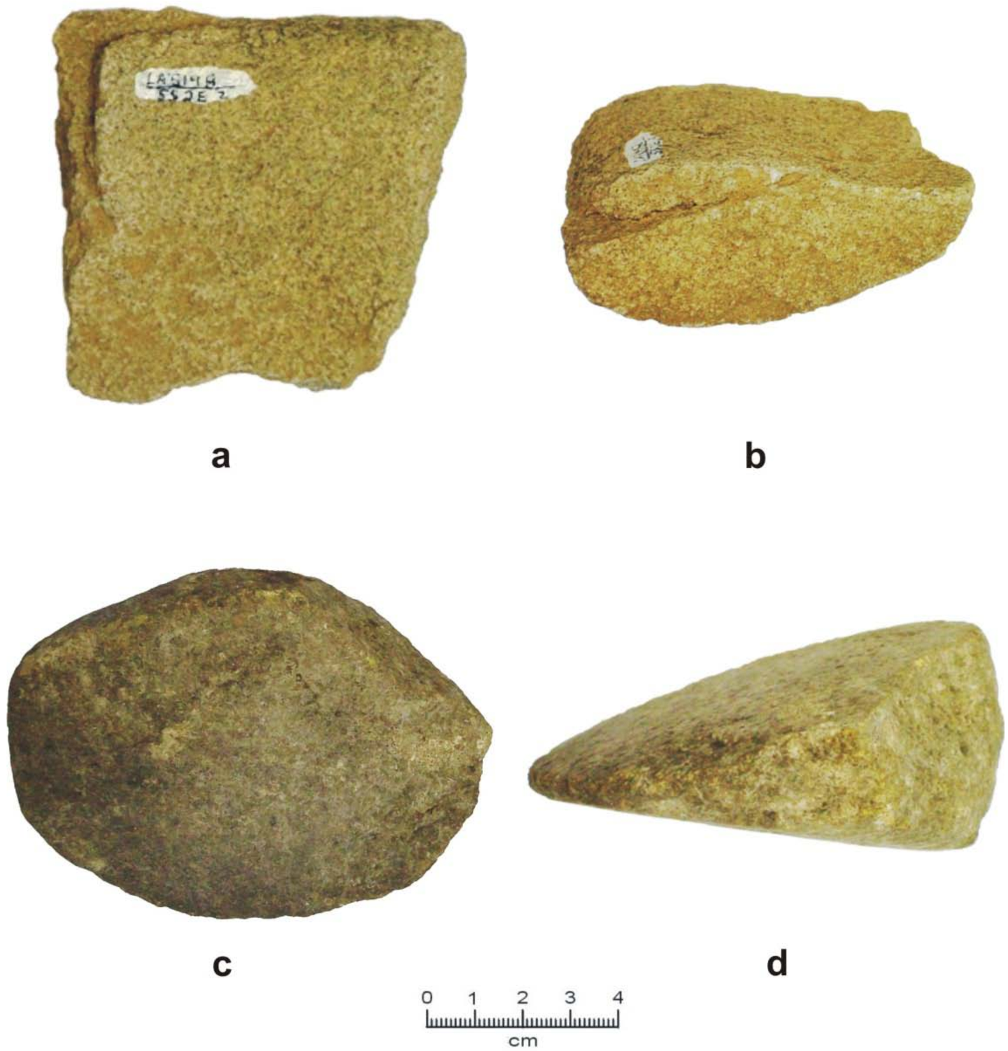

Figure 12.14 Representative ground stone samples

a) surface view of Specimen 199, a sandstone metate fragment and b) side-view of Specimen 199 showing curvature of metate; c) surface view of Specimen 439, limestone metate and d) side view of Specimen 439 showing extent of modified surfaces

Many of the metate fragments were slab-style or shallow basin fragments, made primarily from sandstone or limestone. According to Adams (1999), flat or concave metates and manos were more efficient for grinding oily seeds, and later in the archaeological record, soaked maize kernels. Having higher oil content, or having the kernels soaked before grinding, made it easier to keep them on the flat grinding surface. Hard seeds and kernels, however, scatter unless confined to a deeper basin or trough metate. Adams (1999) also states larger manos are generally associated with trough metates, and smaller manos with flat or concave metates. The Laguna Plata assemblage appears to correlate with Adams' (1999) suggestions on the function and technique behind slab or concave metates and their accompanying manos.

The fragmentary condition of the ground stone assemblage precluded detailed comparisons; however, several observations are presented that offer insight into the use of ground stone implements. Most of the metates and metate fragments were smaller, slab or basin forms, possibly suggesting diversity in resource selection, including seeds, grains, and possibly smaller quantities of maize. The flat use-wear surfaces correlate with flat metates, as a basin metate would result in curvature of the mano. Smaller seeds would be a more prevalent food source, which would necessitate the flat or concave metates and smaller, one-handed manos. Based on the variety of ground stone tools found, multipurpose food procurement is recognized. This is indicative of domestic plant preparation, which is usually associated with pit houses. Among more sedentary, agricultural societies inhabiting LA 5148, as evidenced by the presence of structures, we would not expect to find heavy, trough metates and larger, two-handed manos for dry kernel grinding at sites with late Formative period occupations.

13.0 Ceramic Assemblage Analysis

Peter C. Condon and Adriana Romero

Analysis of ceramic types identified in the LCAS collection and recovered during the TRC survey provided a means of sorting specific pottery styles according to temporal and spatial significance and oftentimes function (Figure 13.1). Of the 7,626 pottery sherds in the combined LCAS collection (n=7,602) and TRC survey assemblage (n=24), 3,109 were analyzed by TRC. The remaining 4,517 sherds were analyzed by Regge Wiseman from the Office of Archaeological Studies, Department of Cultural Affairs, Santa Fe, New Mexico, as a joint research strategy with TRC. Wiseman's findings are of general concurrence with our assessment and are included, in part, in this section. Wiseman's full, unedited assessment is presented in Appendix K. The Laguna Plata field work preceded (April 2010) the ADCW held in May, and the laboratory analysis preceded distribution of the workshop results (Railey 2010). However, most of the attributes incorporated into the final workshop coding spreadsheets and guidelines were used for the Laguna Plata analysis, and can be, for the most part, converted into the ADCW format.

As suggested by Hogan (2006), Miller (1995), and Wiseman (2002), ceramic groupings were segregated by regional traditions based on the presence or absence of surface decoration, temper type, surface texture, and rim morphology. Local pottery types recognized in this study included Jornada Brown, Jornada Decorated, and McKenzie Brown. Nonlocal pottery types included South Pecos Brown, El Paso brownware, El Paso Brown, El Paso Bichrome, El Paso Polychrome, El Paso Decorated, Mimbres whiteware, Playas Red, Chupadero Black-on-white, Three Rivers Red-on-terracotta, Lincoln Black-on-Red, Gila Polychrome, St. John's Polychrome, Ramos Polychrome (including a single example of Capulin style), and Corona Corrugated. Wiseman also identified Alma Plain, Salado Polychrome, and possibly Gallo/Middle Pecos Micaceous Brown variants. An indeterminate category was also created for sherds that could not be identified. The recognized types within each group are described and relevant trends are discussed.

Miller (1990) noted that small and eroded El Paso brownware sherds are difficult to identify by type. Therefore, sherds less than 3-cm in diameter were not analyzed by TRC; however, a sample was provided to Regge Wiseman for further analysis. The 3-cm diameter size was followed due to the analytical limitations and less likelihood of gleaning meaningful information from the small sherds, in addition to the BLM having approved this approach in TRC's proposal for testing and surveying the Laguna Plata site (TRC 2010:12).

13.1.1 Ceramic Types

13.1.1.1 Jornada Brown

Jornada Brown, including Jornada Decorated (0.032 percent/n=1) is regionally associated with southeastern New Mexico, particularly the Pecos River Valley and has the highest occurrence (67.73 percent/n=2,106) (Figure 13.1). This unpainted pottery type is distinguished from the El Paso brownware variants by a range of brown coloring, exterior and occasional interior polish and smoothing, and fine sand or grit temper (Hill 1996; Wiseman 2003; Zamora 2000). Viewed as utilitarian ware, this pottery type dates as early as A.D. 200/400 to 1250/1350 (Hogan 2006). Jornada Brown is associated with the Formative I and VII phases of the Katz and Katz (1993) cultural sequence.

13.1.1.2 South Pecos Brown

South Pecos Brown is a locally manufactured pottery type that exhibits smoothed-to-polished interior and exterior surfaces, tan to blackish-orange paste, and slightly tapering rim profiles (Jelinek 1967:53) (see Figure 13.1). Temper commonly includes feldspar and magnetite. South Pecos pottery rarely displays decoration or design reliefs, but when these are applied they tend to take the form of broad red lines or solid red interiors (Jelinek 1967:53). South Pecos Brown is possibly derivative of Jornada Brown and dates between A.D. 900 and 1200 (Wiseman 2003:164). The South Pecos Brown assemblage included 230 sherds (7.39 percent). South Pecos Brown is associated with the Formative VI and VI phases of the Katz and Katz (1993) cultural sequence.

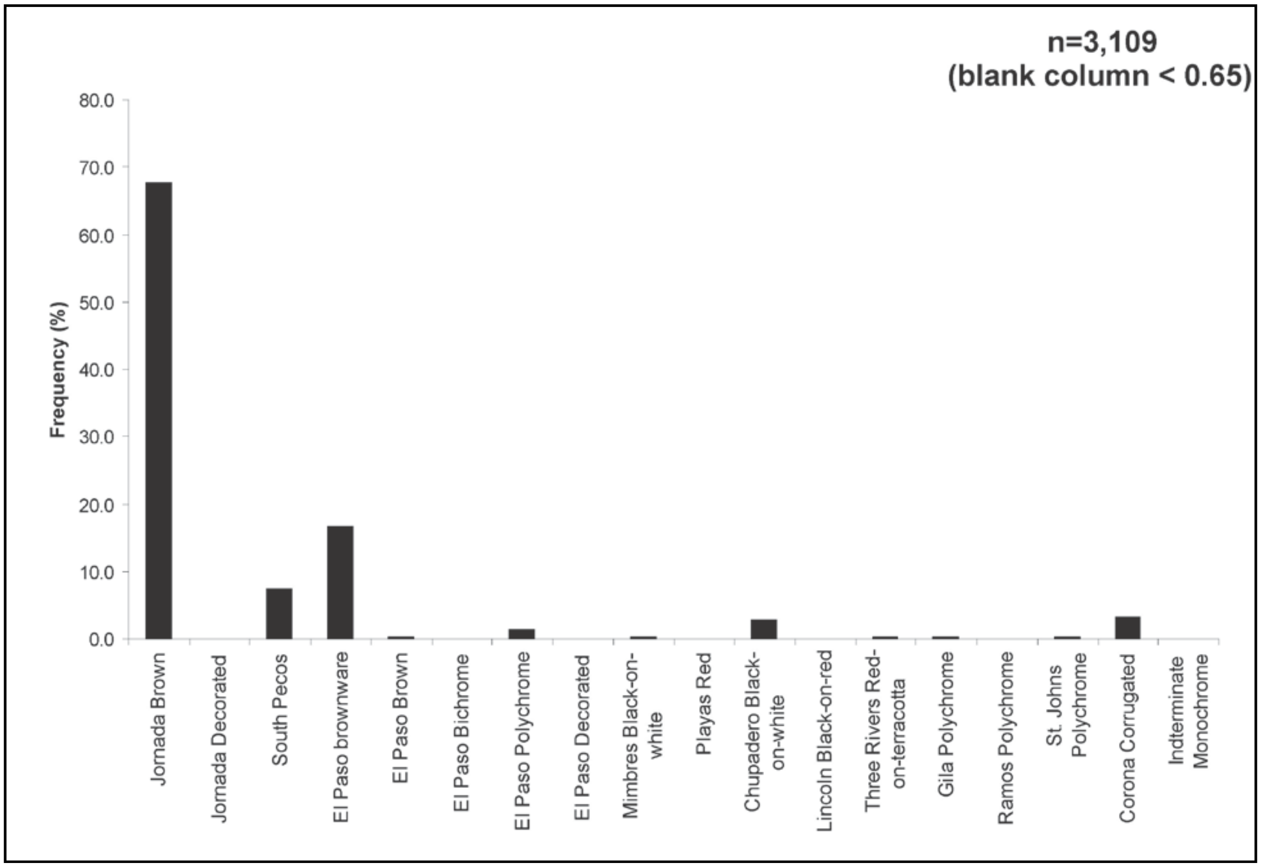

Figure 13.1 Frequency distribution of pottery types identified in the LA 5148 assemblage

13.1.1.3 Middle Pecos Micaceous Brown

Middle Pecos Micaceous Brown as defined by Jelinek (1967) is a brownware variant possibly originating near Fort Sumner, and dates between A.D. 900 and 1300 (Haskell 1977:239; Katz and Katz 1993). Katz and Katz (1993) suggest that Middle Pecos Brown may occur as early as A.D. 500 in the region and be replaced by other brownware variants by A.D. 1075. Haskell's (1977:239) petrographic analysis confirms that the most diagnostic mineral is quartz. Biotite mica also occurs in high frequencies resulting in a distinctive appearance. At least four Middle Pecos Micaceous Brown sherds were noted in the LCAS-under 3 cm diameter assemblage by Wiseman and occurs within the Formative (II/III) IV through VI phases of the Katz and Katz (1993) cultural sequence.

13.1.1.4 McKenzie Brown

McKenzie brown is recognized at least twice in the LCAS assemblage and is distinguished by quartz, off-white feldspar, and golden biotite (Wiseman Appendix K). Six sherds of McKenzie Brown were noted by Zamora (2000:65) who described it as having crushed quartz temper, with tan to black paste, and smoothed to polish surfaces. Wiseman (2003:164) identified McKenzie Brown sherds in the under 3 cm diameter assemblage. McKenzie Brown variants date between A.D. 1100 and 1300, which occurs within the Formative IV through VI phase cultural sequence.

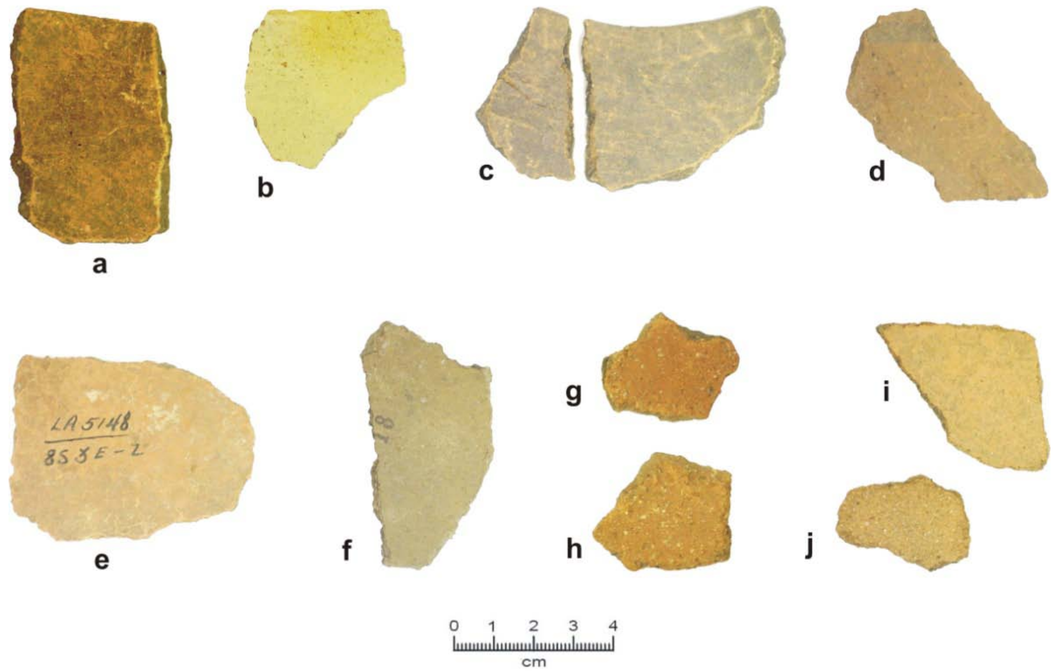

Figure 13.2 Representative Jornada Brown rim sherds, Jornada Decorated, and South Pecos Brown sherds

Jornada Brown rim sherds a) Specimen 561-1, b) Specimen 561-2, and c) Specimen 471 1 and 2 (conjoined); Jornada Decorated: d) Specimen 218; South Pecos Brown body sherds: e) Specimen 165, f) Specimen 642-1, g) Specimen 642-2, h) Specimen 642-3, i) Specimen 648-1, and j) Specimen 648-2

13.1.1.5 El Paso brownware

El Paso brownware, a catch-all classification for Rio Grande manufactured brownwares that cannot be placed into one of three distinct brownware variants: 1) El Paso Brown, 2) El Paso Bichrome, and 3) El Paso Polychrome. This pottery type was the most prevalent nonlocal pottery type identified at LA 5148 and distinguishable from other nonlocal, unpainted brownware variants by large rounded quartz or granite temper. El Paso brownware sherds exhibit little polish and range from lighter brown to dark brown. This pottery type is generally given a broad temporal span of A.D. 200/400 to 1450; however, when associated with one of the temporally discrete brownware variants a more refined age is commonly assigned. The El Paso brownware assemblage consisted of 516 sherd (16.59 percent), and is associated with the Formative I and VII phases of the Katz and Katz (1993) cultural sequence.

13.1.1.6 El Paso Brown

This local pottery type is indistinguishable from El Paso brownware in temper characterization and color. The distinguishing attribute is the presence of a pinched or rounded rim, which provides a diagnostic trait by which to identify and classify this ceramic type. This pottery type is commonly within the project area, as well as throughout west Texas, southeastern New Mexico, and northern Chihuahua, Mexico (Kenmotsu et al. 2008:5-2). In the Rio Grande region, El Paso Brown is assigned to the Mesilla phase of the Formative period and dates between A.D. 200/400 and 1000/1100 (Miller 1995, 2007). The El Paso Brown assemblage consisted of eight sherds (0.25 percent) and is associated with the Formative I and IV phases of the Katz and Katz (1993) cultural sequence.

13.1.1.7 El Paso Bichrome

El Paso Bichrome is a brownware variant associated with the Rio Grande region and is indistinguishable from other Rio Grande brownware sherds except for the increased polish and smoothing, as well as by the decorated Red-on-brown and Black-on-brown slip on the exterior surface (Kenmotsu et al.2008:5-2). Los Tules is the type-site for this pottery form, which is considered to be the predecessor to El Paso Polychrome (Lehmer 1948). El Paso Bichrome is assigned to the Doña Ana phase of the Formative period in the Rio Grande region and dates between A.D. 900/1000/1100 and 1200/1250 (Miller 1995, 2007). A single El Paso Bichrome sherd was identified in the LCAS assemblage (0.032 percent/n=1) and is associated with the Formative III through VI phases of the Katz and Katz (1993) cultural sequence.

13.1.1.8 El Paso Polychrome

El Paso Polychrome is an identifying trait of the El Paso phase of the Formative period (A.D. 1200 to 1450) and is distinguished from El Paso Bichrome and other intrusive polychromes by a graying to brown paste, large angular to subangular quartz, feldspar, gypsum temper; and a decorated exterior surface consisting of alternating thin lines or stepped linear designs (Figure 13.3). Rims are often rounded, expanding, and flared outward from the vessel collar (Kenmotsu et al. 2008; Runyan and Hedrick 1987). The El Paso Polychrome assemblage consisted of 38 sherds (1.22 percent) and is associated with the Formative VI and VII phases of the Katz and Katz (1993) cultural sequence.

13.1.1.9 El Paso Decorated

El Paso Decorated is a catch-all category for local brownware sherds exhibiting decorative motifs that cannot be confidently identified as El Paso Bichrome or El Paso Polychrome. El Paso Decorated pottery types generally date between A.D. 1200 and 1450. A single El Paso Decorated sherd was identified in the LCAS assemblage (0.032 percent/n=1) and is associated with the Formative III and VII phases of the Katz and Katz (1993) cultural sequence.

13.1.1.10 Alma Plain

Alma Plain is characterized as a plain brownware ceramic and is thought to originate in the southwestern portion of New Mexico (Hill 2001; Runyan and Hedrick 1987). This pottery type is at times indistinguishable from Jornada Brown and overlaps in regional distribution. The distinguishing characteristic of this pottery type is the tuff used as temper and which separates it from other similar regional brownwares. Alma Plain is dated between A.D. 200/400 and 650 and is associated with the Formative I phase of the Katz and Katz (1993) cultural sequence. The Alma Plain assemblage consisted of at least 17 sherds as recognized by Wiseman within the under 3 cm diameter assemblage (Appendix K).

13.1.1.11 Mimbres whiteware

Mimbres whiteware pottery originates in the Mimbres River Valley east of the Mimbres Mountain range and south of the Pinos Altos Mountain range. Mimbres whitewares are characterized by a light gray, dull white paste with medium to fine sand temper. Design motifs appear to be spatially and temporally sensitive (Shafer and Brewington 1999). This pottery type is identified throughout the Mogollon region and is associated with the late Mesilla and Doña Ana phases of the Formative period in the Rio Grande valley and the Formative I through V in the Pecos River valley. Based on Shafer and Brewington (1999), Mimbres pottery is subdivided into three main categories: Style I (A.D. 750 to 900), Style II (A.D. 880 to 1020), and Style III (A.D. 1010 to 1130). The Mimbres whiteware assemblage consisted of three sherds (0.09 percent) and is associated with the Formative II through V phases of the Katz and Katz (1993) cultural sequence.

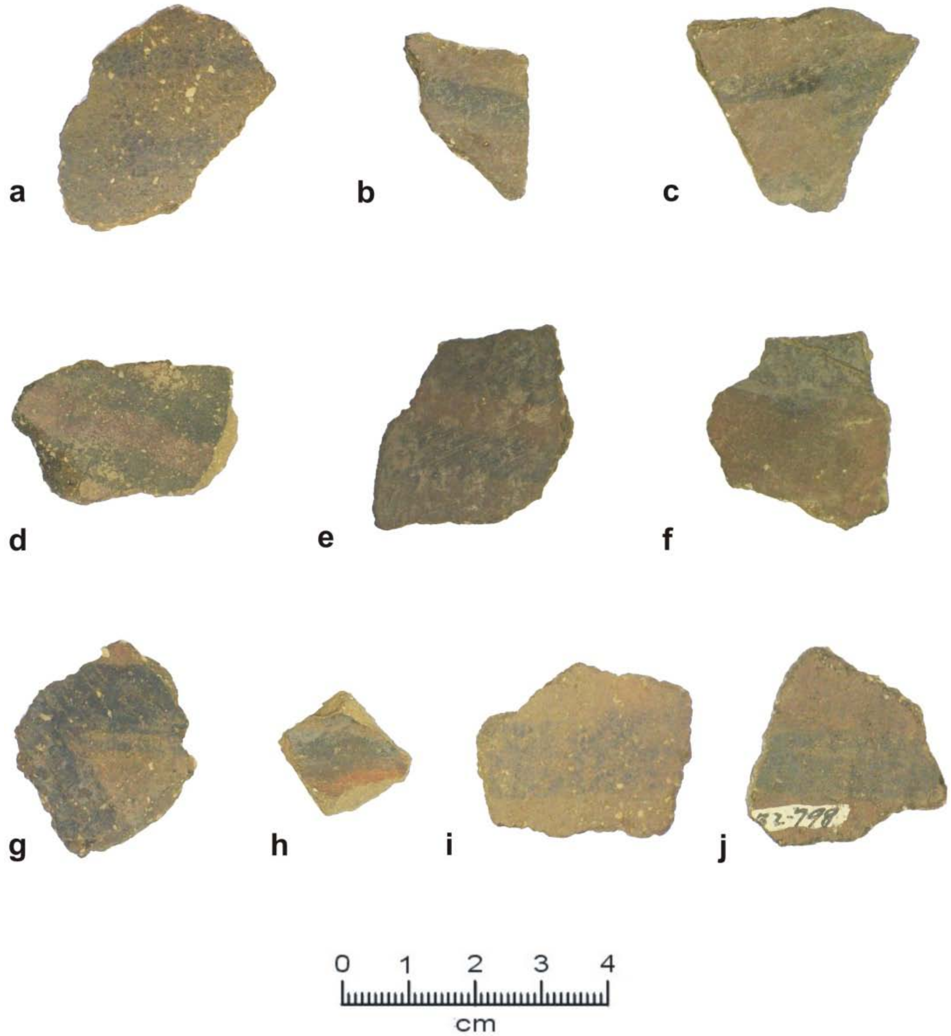

Figure 13.3 Representative El Paso Polychrome sherds

a) Specimen 541-1, b) Specimen 541-2, c) Specimen 539, d) Specimen 543-1, e) Specimen 543-2, f) Specimen 543-3, g) Specimen 171-1, h) Specimen 171-2, i) Specimen 582-1, and j) Specimen 582-2

13.1.1.12 Chupadero Black-on-white

This pottery type is characterized by a dense gray to white homogeneous paste surface over which black colored hatches and solid motifs are applied (Wilson 2003:166–167) (Figure 13.4). Manufacturing of Chupadero Black-on-white pottery is thought to occur in south-central New Mexico, but sherds are found throughout the Trans-Pecos region. Wiseman (Appendix K) identified very fine-to-fine crushed rock and sherd temper in several of the sherds. This pottery dating between A.D. 1050/1100 and about 1450/1550, is associated with the Doña Ana and El Paso phases of the Rio Grande Formative period and the Formative III through VII of the Katz and Katz (1993) cultural sequence. The Chupadero Black-on-white assemblage consisted of 85 sherds (2.73 percent) identified in the greater than 3 cm diameter assemblage.

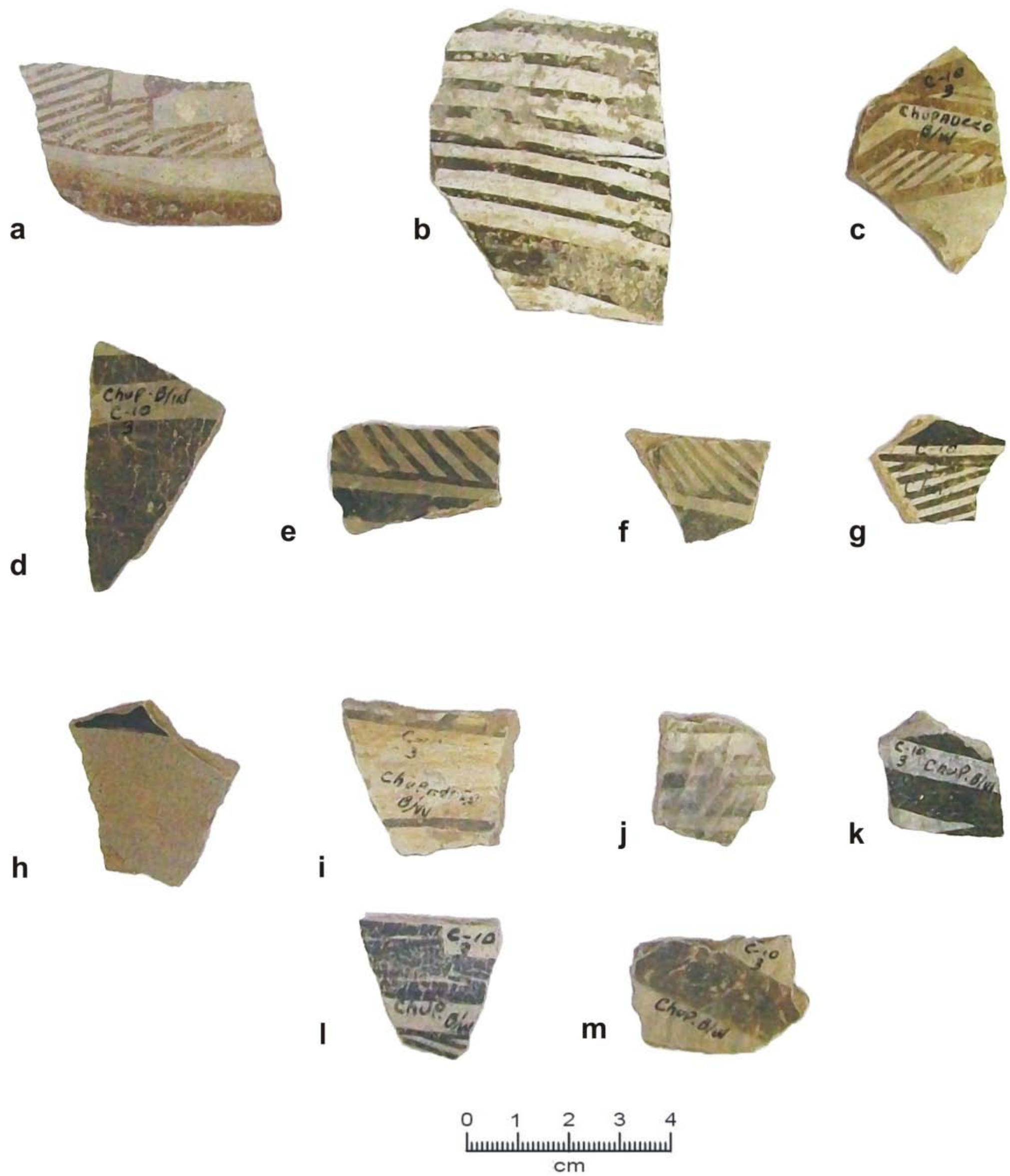

Figure 13.4 Representative Chupadero Black-on-white sherds collected from LA 5148

a) Specimen 489, b) Specimen 137, c) Specimen 536-1, d) Specimen 536-2, e) Specimen 536-3, f) Specimen 536-4, g) Specimen 536-5, h) Specimen 536-6, i) Specimen 536-7, j) Specimen 536-8, k) Specimen 536-9, l) Specimen 536-10, and m) Specimen 536-11

13.1.1.13 Three Rivers Red-on-terracotta

Three Rivers Red-on-terracotta sherds occurred infrequently at LA 5148 (Figure 10.30). This pottery type is thought to originate in south-central New Mexico and is characterized by red painted decorations over an orange to brownish-red slipped surface (Wilson 2003:166; Wiseman 2003). This pottery dates between A.D. 1100 and 1300 and is generally represented by bowl vessel forms. The Three Rivers Red-on-terracotta assemblage consisted of eight sherds (0.25 percent) in the greater than 3 cm diameter assemblage and is associated with the Formative IV through VI phases of the Katz and Katz (1993) cultural sequence.

13.1.1.14 Playas Red

Playas Red is traditionally viewed as an intrusive pottery type from the Casas Grandes region of Mexico (Runyan and Hedrick 1987). This pottery type is further characterized by a grayish brown to dark gray paste, medium texture temper consisting of feldspar and quartz, and smoothing of the interior and exterior surfaces (Runyan and Hedrick 1987; Wiseman 2003). A red or red-brown slip is a distinguishing trait as are the slightly everted rims. This pottery type dates between A.D. 1150 and 1450 and is associated with the Formative V through VII phases of the Katz and Katz (1993) cultural sequence. A single Playas Red sherd greater than 3 cm in diameter was identified in the assemblage (0.03 percent/n=1).

13.1.1.15 Lincoln Black-on-Red

Lincoln Black-on-red is identified by stylistic and color-related characteristics that distinguish this pottery from its predecessor, Three Rivers Red-on-terracotta (see Figure 13.5). Dates given for this type range from A.D. 1300–1450 (Lyons 2004). Lincoln Black-on-red is found in both jar and bowl form, and although similar to Three Rivers Red-on-terracotta, differs in the reddish underlying exterior pigment and the narrow band directly below the rim (Wiseman 2002:103). Moreover, the bottom of vessel is often painted, but not decorated. Design elements are similar to those found on Three Rivers Red-on-terracotta vessels. Wiseman (Appendix K) identified the use of gray feldspar temper and fine crystalline temper w/ hematite aggregates in select samples of this pottery type. Two sherds (0.06 percent), greater than 3 cm in diameter, were identified in the LCAS collection.

13.1.1.16 Ramos Polychrome

Ramos Polychrome traditionally originates in the Casas Grandes region of Mexico and is commonly recovered from sites dating between A.D. 1300 and 1400 (Miller 1995). This pottery type has at least two primary decorative motifs that include fine-line red and black designs and thick red and black designs more commonly associated with Villa Ahumada Polychrome over a light colored paste (Dering et al. 2001; Miller 1995). A single Ramos Polychrome sherd greater than 3 cm in diameter was in the assemblage (0.03 percent/n=1) and is associated with the Formative VII phase of the Katz and Katz (1993) cultural sequence (see Figure 13.5). Wiseman (Appendix K) identified one additional Ramos Polychrome, possibly of the Capulin style, in the less than 3 cm diameter assemblage.

13.1.1.17 St. John’s Polychrome

St. John’s Polychrome exhibits a distinctive orange-red slip on the interior and less frequently on the exterior. Design motifs include black longitudinal hatching and interlocking scrolls, with gray to cream-colored paste. This pottery originates along the western margins of the Jornada Mogollon region near St. Johns, Arizona, and dates between A.D. 1200 and 1300 (Miller 1995; Runyan and Hedrick 1987). Three sherds greater than 3 cm in diameter were in the assemblage (0.096 percent/n=3). They are associated with the Formative VI and VII phases of the Katz and Katz (1993) cultural sequence (see Figure 13.5).

13.1.1.18 Gila Polychrome

Gila Polychrome is associated with the Salado culture and is geographically identified with the Mogollon Rim of Arizona, southwestern New Mexico, and less frequently, west Texas. Stylistically, Gila Polychrome is identified by black-on-white decorative designs separated by bands of red slip on the interior of bowls, and black-on-white design motifs on the exterior of jars. Common design motifs include triangles, checkerboards, terraces, hatching, and interlocking scrolls (Ciolek-Torrello; Crown 1994:44 and Lange 1990:134). Gila Polychrome was produced from about A.D. 1300–1400 and is associated with the Formative VII phase of the Katz and Katz (1993) cultural sequence. Four sherds (0.12 percent) were identified in the LCAS collection (see Figure 10.30).

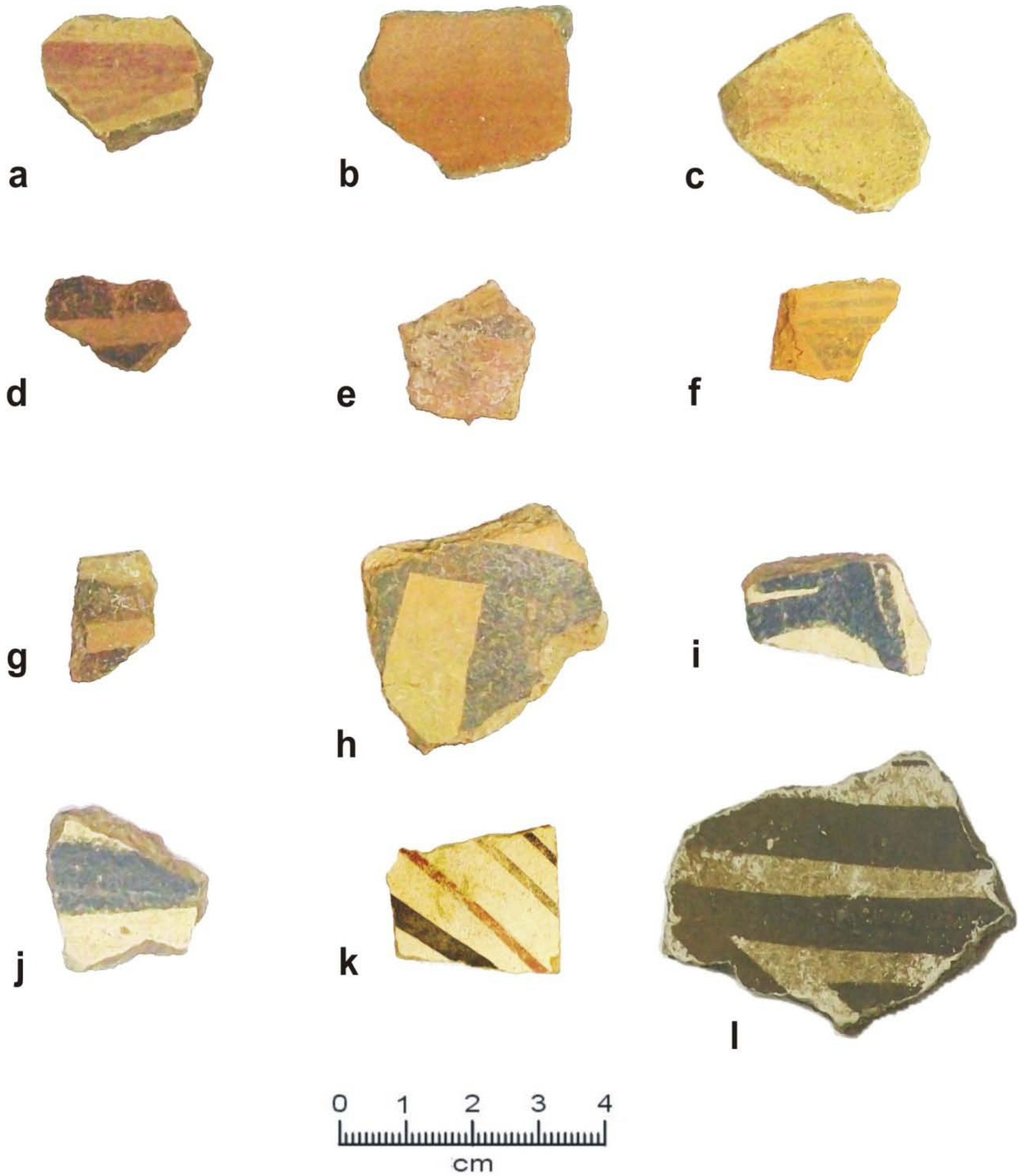

Figure 13.5 Representative nonlocal sherds from LA 5148

Three Rivers Red-on-terracotta: a) Specimen 501, b) Specimen 465, and c) Specimen 531; St. John's Polychrome: d) Specimen 13, e) Specimen 37, and f) Specimen 48; Lincoln Black-on-red: g) Specimen 518 and h) Specimen 517; Gila Polychrome: i) specimen 243-1 and j) Specimen 243-2; Ramos Polychrome: k) Specimen 236, and Mimbres Black-on-white: l) Specimen 461

13.1.1.19 Corona Corrugated

Corona Corrugated occurred in relatively high frequencies in the LCAS collection with 100 sherds (3.12 percent) identified in the greater than 3 cm diameter assemblage (Figure 13.6). This pottery type co-occurs with Chupadero Black-on-white pottery types and dates between A.D. 1225 and 1460 (Kelley

1984; Wiseman 2002). Originating in the Sierra Blanca region northwest of LA 5148, Corona Corrugated exhibits indentations that point inward into the vessel and downward; resulting in a pattern that resembles a series of continuous squares. It is most commonly associated with Gran Quivera (Hayes et al. 1981), and citing Wiseman (2003:87), at Lincoln phase sites in the Sierra Blanca region. Corona corrugated is associated with the Formative VI and VII phases of the Katz and Katz (1993) cultural sequence.

13.1.1.20 Indeterminate Ceramic Type

This category included all pottery sherds that could not be assigned a definitive type classification. Indeterminate pottery is assumed to date between A.D. 200 and 1450, however, this temporal bracket is tentative. One (0.032 percent) monochrome sherd was placed into the indeterminate type category.

13.1.2 Vessel Form Analysis

Vessel form categories included the shape and portion of a jar or bowl, which the sherd represents. Sherds were categorized based on rim shape, the presence and location of decoration or slip color, sherd curvature, vessel portion, and thickness. Standardized vessel forms were limited to bowls and jars, each being distinguished from one another based on whether the orifice is restricted or unrestricted and whether or not a neck or collar is present. Unrestricted openings are defined as having an orifice diameter nearly as great, or greater, than the maximum body diameter. Restricted openings exhibit a minimum rim or neck orifice diameter substantially narrower than its maximum vessel body diameter (Bennett 1974; Rice 1987). Bowls were generally defined as open vessels with unrestricted openings, rounded or conical in shape, and relatively shallow in depth. Bowls were tentatively interpreted as noncooking items but used for a variety of other functions based on vessel opening.

Jars were defined as restricted vessel forms oftentimes with or without necks, relatively deep in comparison to width, with or without handles (e.g., lugs), and round or conical in shape. Jars were tentatively associated with cooking functions and storage and were similar to neckless jars or tecamates and ollas, or wide-mouthed vessels (Miller 1995). Vessel form was initially conducted on the larger ceramic sample groups, including Jornada Brown, South Pecos Brown, El Paso brownware, El Paso Polychrome, Corona Corrugated, and Chupadero Black-on-white (Figure 13.7). Of the 2,106 Jornada Brown sherds analyzed, 87.36 percent (n=1,840) were classified as jars. The South Pecos Brown assemblage (n=230) primarily consisted of jar forms (93.04 percent/n=214). Rio Grande types, consisting of El Paso brownware (n=516) and El Paso Polychrome (n=38) ceramics, included 507 (98.25 percent) and 36 (94.73 percent) jar forms, respectively. Seventy-nine (92.94 percent) of the 85 Chupadero Black-on-white sherds were classified as jars. Of the 100 Corona Corrugated sherds, 99 percent (n=99) were identified as jars. Jars are the primary vessel form in the assemblage, with unrestricted bowl forms comprising a small percentage of the assemblage.

When less numerous pottery types are examined there is a more complex result. For instance, the Three Rivers Red-on-terracotta sherds (n=8) consisted of six bowl sherds, one jar sherd, and one indeterminate sherd. In a similar fashion, Lincoln Black-on-red sherds (n=2) are interpreted as singular bowl vessel forms. Four Gila Polychrome sherds were identified, of which three are bowls. Two of the three Mimbres Black-on-white sherds are consistent with bowl forms. In contrast, eight El Paso Brown sherds were identified, of which all are classified as jars. This pattern indicates jars are the predominate vessel form across time. However, exotic pottery types commonly represent bowls rather than more functionally flexible jars. This pattern stands in contrast to the expected increase in bowl forms as sedentism becomes more widespread and serving vessels, rather than storage/cooking jars, may have become more widespread. The high frequency of jars suggests, on a broad level, mobility continued to be the norm the occupants at LA 5148.

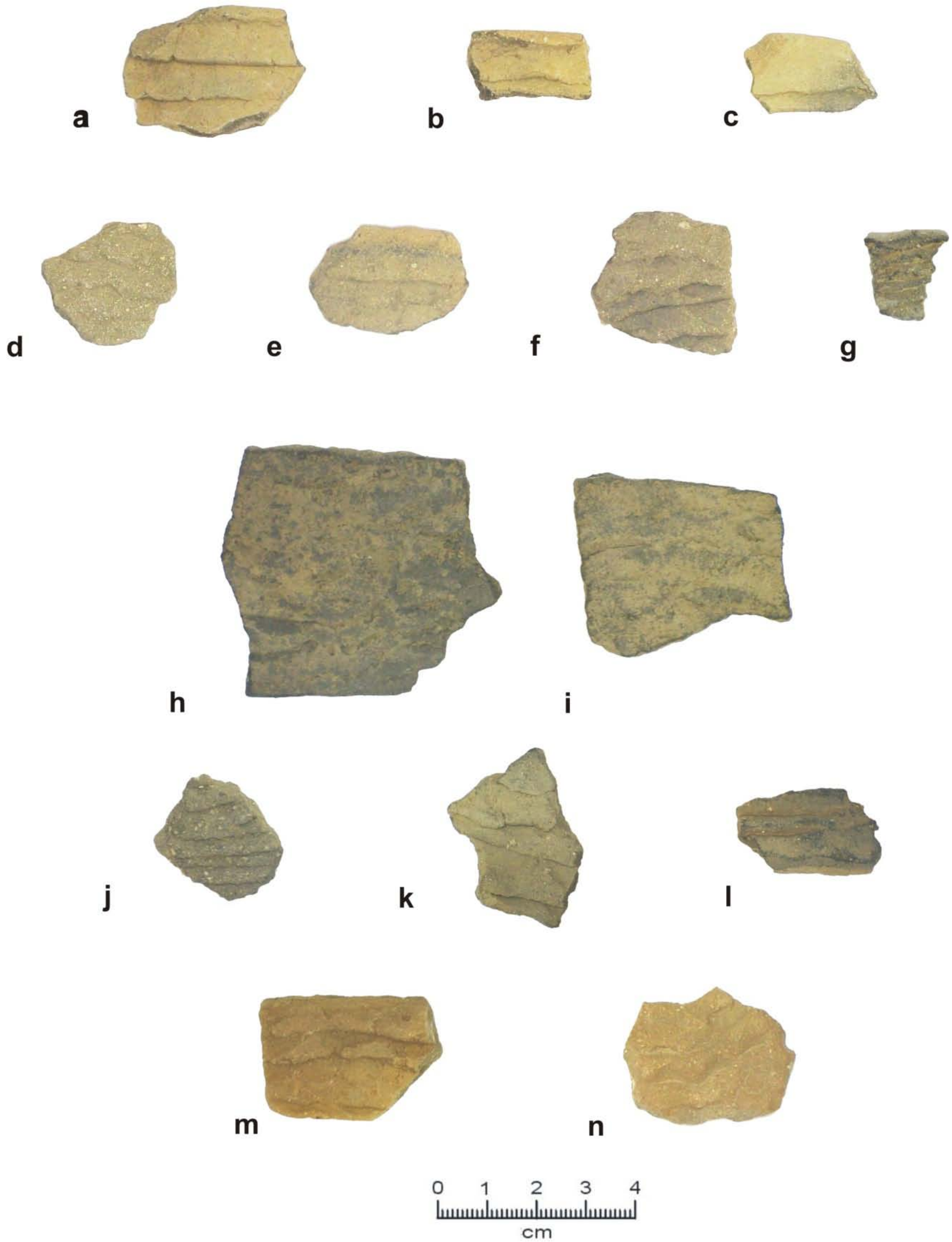

Figure 13.6 Representative Corona Corrugated sherds from LA 5148

a) Specimen 558-1, rim, b) Specimen 558-2, rim, and c) Specimen 558-3, rim, d) Specimen 551-1, e) Specimen 555-2, f) Specimen 560-1, g) Specimen 560-2, h) Specimen 647-1, i) specimen 647-2-1, j) Specimen 554, k) Specimen 558-4, l) Specimen 558-5, m) Specimen 558-6, and n) Specimen 558-7

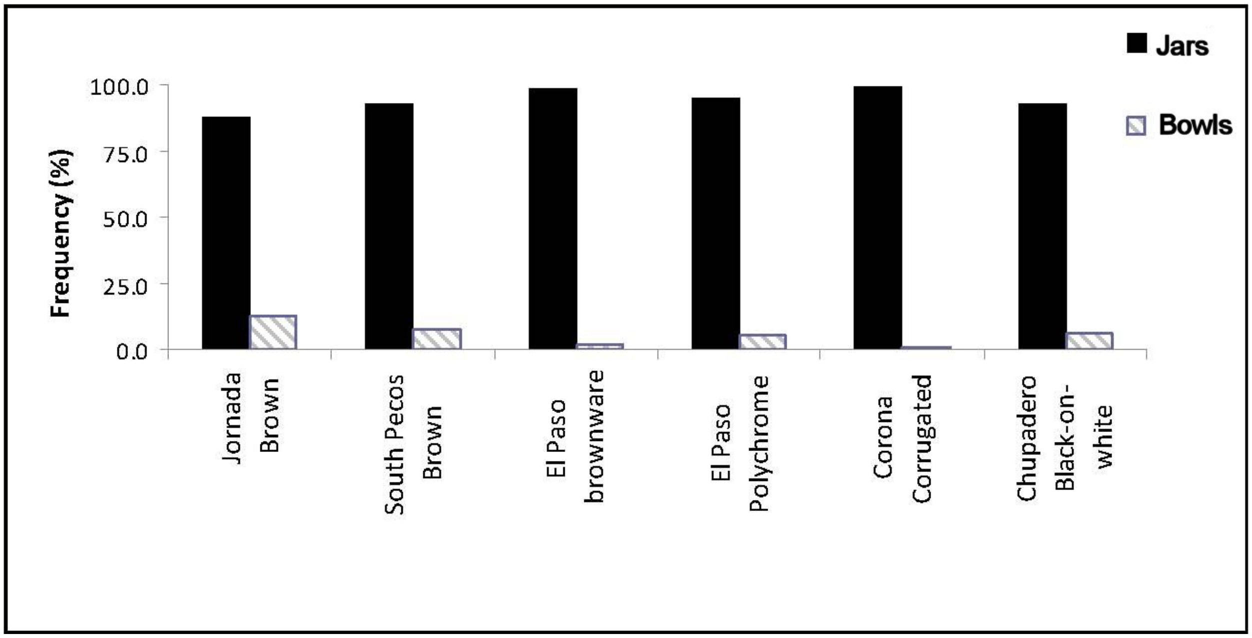

Figure 13.7 Frequency graph showing the distribution of vessel form

13.1.3 Vessel Orifice Analysis

One of the most critical vessel attributes for interpreting function is orifice or vessel opening of the jar, bowl, or pitcher. Wide or unrestricted vessel openings permit ease of access, ease of identification, and may infer frequent utilitarian use. In contrast, narrow or restricted openings do not permit ease of access and by design may be used to keep the contents contained either during cooking, transport, or storage (Rice 1987). Dering et al. (2001) suggests orifices 7 cm or larger may be utilitarian in function and served as cooking vessels. Orifices were measured by using a standardized diameter measuring template applied to rim curvature (Rice 1987:223, Figure 7.9) to yield an estimated orifice diameter of a vessel.

A sample of 37 rim sherds from the assemblage were analyzed for orifices using a rim diameter template (Figure 13.8). Of the 37 rims, only 26 were large enough for this study, eliminating El Paso Brown (n=1) as a study group. The remaining sample group consisted of 11 Jornada Brown rims, five Corona Corrugated rims, and nine El Paso Polychrome rim sherds. Each of these pottery types were analyzed individually and then compared to each other.

The Jornada Brown rim sherds have an average vessel opening of 16.18 cm (standard deviation of 6.16 cm) with an orifice range of 7–27.0 cm. The mean orifice diameter for the Corona Corrugated sample was 18.8 cm (standard deviation of 3.96 cm) with a range of 12–24 cm. The El Paso Polychrome sample yielded a mean diameter of 17.17 cm (standard deviation of 3 cm) with a range of 14–25 cm.

Within the Jornada Brown assemblage (n=11), the orifice diameter ranged between 10–19.99 cm, which comprises 45.45 percent (n=5) of this type. The second most frequent diameter ranged from 20–29.99 cm (36.36 percent/n=4). Diameters of 0 cm–9.99 cm comprised the remaining 27.27 percent (n=3). Sherds with rim orifices between 20 and 29.99 cm in diameter were the most frequent (62.50 percent/n=5) within the Corona Corrugated assemblage. The second most frequent orifice diameter ranged from 10.0 cm–19.99 cm and represented 37.50 percent (n=3) of the corrugated pottery group. Eight sherds (88.88 percent) in the El Paso Polychrome sample group had orifices between 10 and 19.99 cm in diameter. One sherd (11.11 percent) had an orifice between 20 and 29.99 cm.

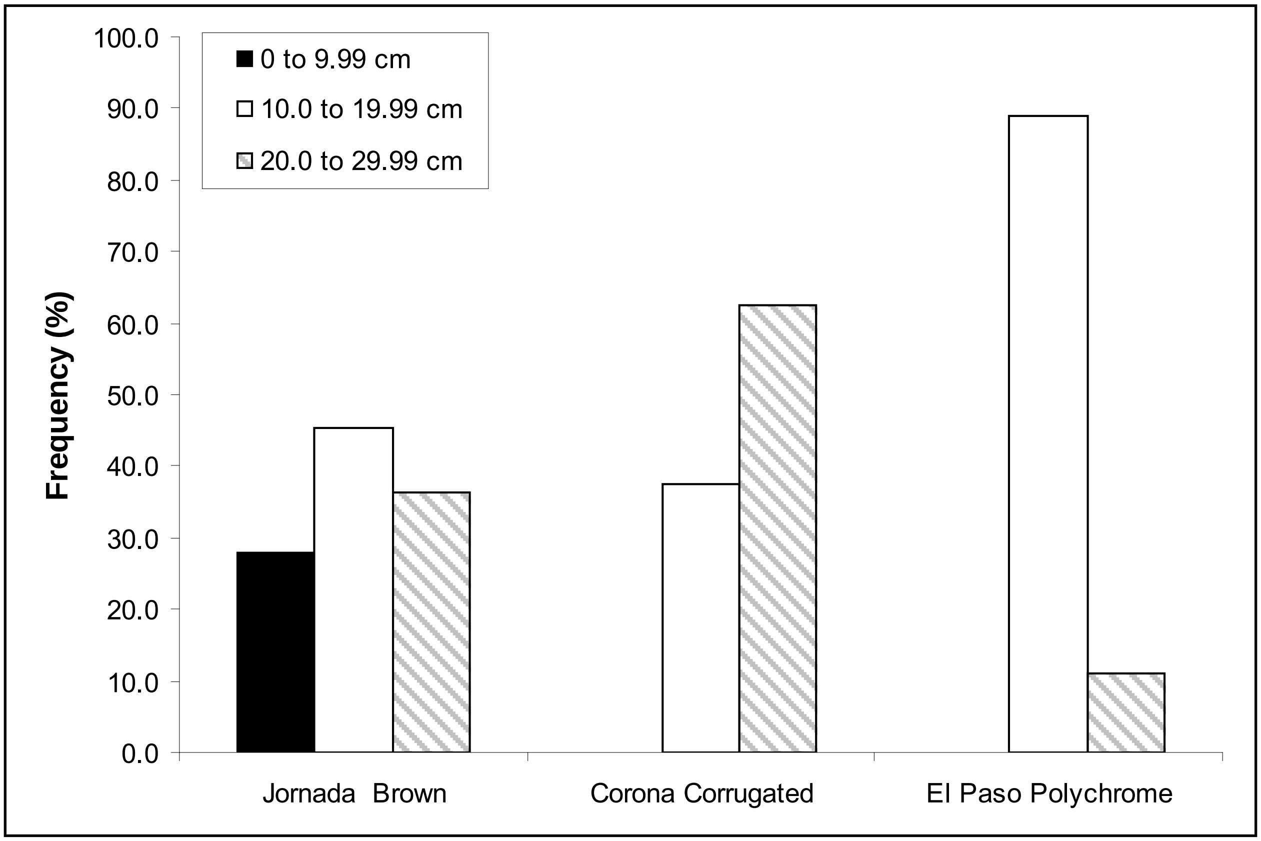

Figure 13.8 Orifice diameter (cm) comparative analysis between Jornada Brown, Corona Corrugated, and El Paso Polychrome rim sherds

Despite a small sample, comparative analysis demonstrates differences in orifice diameter within and between pottery types. Jornada Brown rim sherds (n=11) yield a more even distribution with an orifice diameter between 10 and 19.99 cm. Corona Corrugated demonstrates a skewed distribution with a range of 20–29.99 cm reflecting the highest orifice frequency diameters. El Paso Polychrome also exhibits a skewed distribution with most rim sherds associated with a 10–19.99 cm diameter opening. Most orifices are greater than 10 cm but less than 30 cm in diameter. This may suggest the need to confine a resource within the vessel, yet allow access for cooking or storage. Bowls and open face vessels were not present in the sample group, suggesting bowls were not present in high frequencies, or possibly not identified or collected in higher quantities.

13.1.4 Rim Sherd Analysis: Rim Sherd Index and Rim Form

Analysis of rim form examined the shape and angle of the vessel wall below the rim proper (Bennett 1973). Classification takes into account Carmichael's (1986) study on rim morphology in which rim sherds were temporally seriated by cross section morphology and contour. Rim morphology analysis was a derivative of the rim sherd index by West (1982) and Carmichael (1986), in which rim form was seriated through time based on the ratio between rim thickness to vessel wall thickness. Several studies have conducted RSI analysis, most notably Carmichael (1986), Dering et al. (2001), and Kenmotsu et al. (2008). Using Carmichael's (1986:76) rim sherd index formula, which calculates the ratio between rim sherd thickness recorded at 2 mm and 15 mm below the rim edge, 37 sherds identified in the LCAS collection were analyzed. This sample, although small, provides a proxy measure for establishing a comparative population by which ceramics manufactured in Lehmer's (1948) Jornada Mogollon cultural sphere and those falling in the eastern extension can be evaluated.

RSI= Thickness measured 2 mm below rim/surface juncture

Thickness measured 15 mm below rim/surface juncture

Carmichael (1986) suggests the rim sherd index (RSI) can provide a viable means for distinguishing between rim form variation through time, and in essence, distinguishing rim sherds that commonly occur in the early Formative period from those produced in the late Formative period. Carmichael (1986:81 cf. Blalock 1972:206) presents the following mean index values for early, middle, and late brownware variants associated with the Rio Grande valley, Hueco Bolson, and Tularosa Basin. These pottery types are also identified in the LCAS C-10-C collection: El Paso Brown 0.74 to 0.80, El Paso Brown/Bichrome 0.88 to 0.96, early El Paso Polychrome 1.00 to 1.12, and late El Paso Polychrome 1.31 to 1.43. When compared to the C-10-C collection, we see comparable results. Jornada Brown rim sherds (n=13) yielded a mean index of 0.792. South Pecos Brown (n=9) yielded an index of 0.741. Both of these pottery types appear early in the Formative period sequence and tentatively correlate with the early brownware variants west of the Guadalupe Mountains. Interestingly, the El Paso Brown rim sherds in the C-10-C assemblage (n=8) produced a mean index value of 1.04, well beyond the range established for this pottery type by Carmichael (1986). In fact, this mean value correlates with pottery associated with the early El Paso phase, or the late Formative period (post-A.D. 1250). Eleven El Paso Polychrome rim sherds in the C-10-C assemblage yielded a mean index value of 1.29. This average falls in an acceptable range between Carmichael's (1986:81) early and late El Paso Polychrome range.

To evaluate the four pottery types, a linear regression plot was calculated, resulting in a graphical representation and a correlation coefficient value indicating similarity or difference within the total sample population (Figure 13.9). For this statistical test, n=37 with a significance level of 0.05. The null hypothesis states that there is no difference between the four sample groups. The resulting correlation coefficient value is 0.42, suggesting a minimal relationship between groups; the p-value more definitively indicates there are significant differences between the four samples.

An alternative to the RSI analysis was conducted that classified rim sherds based solely on visibly observed traits as presented in Carmichael (1986). As proposed in Dering et al. (2001:329), basic seriation between four rim shapes: 1) pinched, 2) rounded, 3) flattened, and 4) rounded/flared, should provide a rough estimate of the temporal and cultural sequence for locally made rim sherds. According to Carmichael (1986), pinched/rounded rims with little vertical curvature are generally associated with the early Formative period. Flat rims with expanding vertical walls are tentatively associated with the middle Formative period. Curved, everted rims with rounded and flared cross sections are associated with the late Formative period.

The resulting analyses examined Jornada Brown, Corona Corrugated, El Paso Brown, and El Paso Polychrome rims. A sample group of 37 rims were analyzed (Figure 13.10). Of the 37 sherds, 13 were identified as Jornada Brown rim sherds. Three (n=23.07 percent) were classified as rounded, 38.46 percent (n=5) were identified as rounded/pinched, and 38.46 percent (n=5) exhibited flattened rims.

Nine Corona Corrugated rim sherds were analyzed. Two rounded/pinched (n=2/22.22 percent), two rounded (n=2/22.22 percent), and two rounded/flared (n=2/22.22 percent) rim sherds. Three flattened rim sherds (33.33 percent were also identified. Eight rim sherds were typed as El Paso Brown. Two rounded/pinched rims (n=2/25.0 percent) and two rounded/flared (n=2/25.0 percent) were identified. In addition, four (50.0 percent) rounded rim forms were present. Of note are the two rounded/flared rim types that are more common during the later Formative period. The presence of these later rim styles possibly suggests there is more diversity within early Formative pottery forms than anticipated, or these two rims are actually later pottery forms. Eleven rim sherds are identified as El Paso Polychrome, of which two (18.18 percent) are flattened and flared and nine (81.81 percent) are everted, exhibiting rounded and flaked rim profiles.

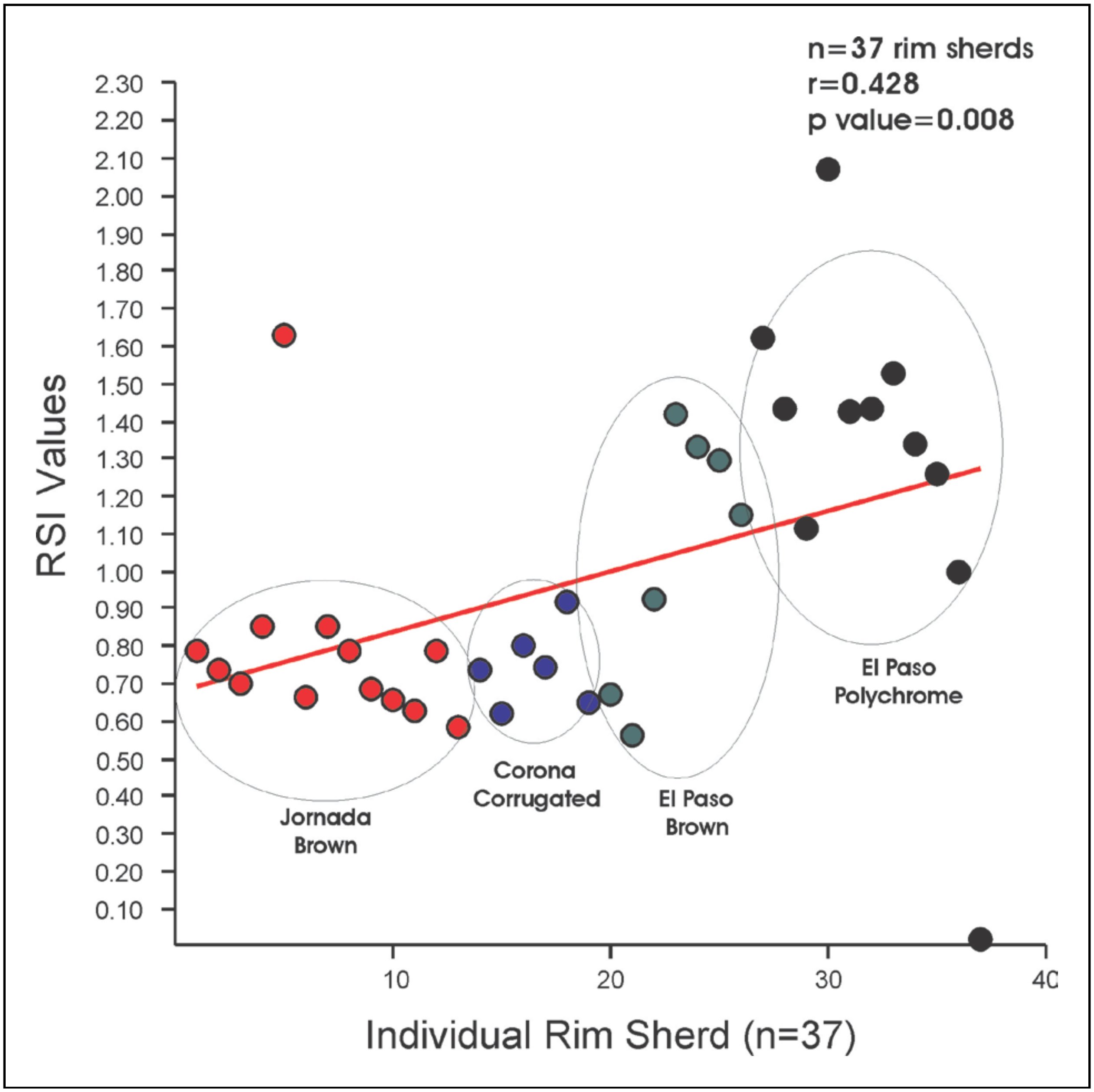

Figure 13.9 Linear regression plot with associated correlation coefficient value for rim sherd index values (n=37)

Based on the rim form analysis, the Jornada Brown and El Paso Polychrome rim sherds conform to the predicted profiles as assigned by Carmichael (1986). Corona corrugated, which is a late regional pottery type, is problematic with regard to the RSI values. Specifically, Corona Corrugated commonly exhibits a pinched, rounded rim that has a lip or overhang at the rim/lateral surface juncture. This rim form falls outside the profile classifications presented here, and although, rounded in form, this pottery dates after A.D. 1200. Seven of the eight El Paso Brown values also fall outside the expected range of 0.74 and 0.80 and the later range of 0.88 and 0.96 (Carmichael 1986:81). This pattern is difficult to explain, but may be rationalized if the rim sherds, despite the absence of decoration, date to the late Formative period, rather than the expected earlier period. Finally, the presence of non-traditional rim forms within each pottery group may also reflect an early introduction, a late continuation, or an early/late pottery type that deviates from the common interpretation.

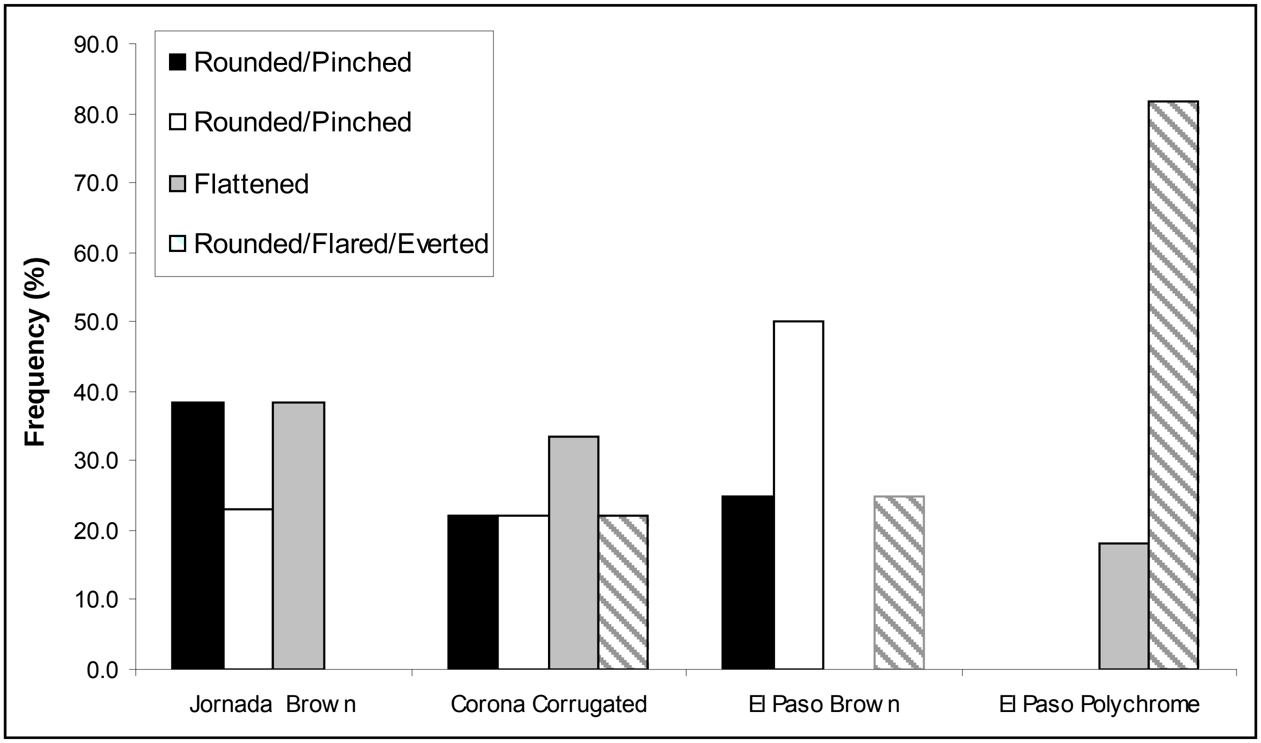

Figure 13.10 Frequency graph showing rim distributions

13.1.5 Ceramic Analysis Summary

Data gleaned from the LCAS ceramic collection indicates three major points: 1) the Formative period occupation at LA 5148, and in particularly the C-10-C locus, was comprehensive, spanning in part the entirety of the Formative period until A.D. 1300/1350; 2) multifunctional narrow-mouthed vessel forms occur in greater frequency suggesting mobility rather than sedentism; and 3) the diversity of non-local pottery types indicate greater regional interaction and social organization.

Ceramic characterization of the Laguna Plata assemblage initially focused on the quantitative, such as pottery classification, rather than qualitative, which includes technological analyses, such as mineral composition or the microstructure of the clay content present in the temper. This was intentional, and guided by the scope of work outlined in earlier chapters of this report. A primary goal of this project was to evaluate the range and frequency of pottery collected by the LCAS and develop an updated version of the classic pottery classification. In doing so, the assemblage would provide both cross-dates to compare to the radiocarbon data and sequence dates, which provide a proxy measure based on how frequently a particular pottery type or style occurs at a particular location (Rice 1987:436). The classification system is based primarily on style, and the identified 17 pottery types within the sample of sherds greater than 3 cm in diameter. An additional four types were present in the second sample of sherds measuring less than 3 cm in diameter. Overall, the ceramic assemblage reflected a range of pottery types, both local and nonlocal in origin. Local pottery types, referring to manufacture primarily west of the Pecos River and east of the Guadalupe Mountains, includes Jornada Brown, Jornada Decorated, and South Pecos Brown.

Occurring with the highest frequency is Jornada Brown (including the one sherd of Jornada Decorated), which like other plain brownwares, provide a relative temporal range between A.D. 200/400 and 1250/1350 and covers the entirety of the Formative period in the Laguna Plata region. South Pecos Brown occurs with less frequency, but spans a period of 300 years (A.D. 900 to 1200). These brownwares appear to correlate stylistically with similar undecorated brownware types, including El Paso Brown, despite being manufactured in the eastern extension of the Jornada Mogollon region (Katz and Katz 1993; Miller 1995). Nonlocal brownware variants that, in all likelihood, have sources northwest and southwest of the Pecos Valley include Middle Pecos Micaceous Brown, McKenzie Brown, and Alma Plain. Middle Pecos Brown dates between A.D. 500 and 1075 and overlaps with Alma Plain, which dates between 200/400 and 650. McKenzie Brown occurs as early as A.D. 1100 and phases out by about 1300. Each of these types is present in low frequencies within the LCAS assemblage.

Within Lehmer's (1948) Jornada Mogollon culture sphere are the Rio Grande pottery types: El Paso Brown, El Paso Bichrome, and El Paso Polychrome. These pottery types also occur in relative low frequencies, but reflect the transition from a plain brown, which flourished from A.D. 200 to 1000/1100, to painted wares after A.D. 800/1000 in the Rio Grande valley. The subsequent introduction of El Paso Bichrome (A.D. 800/1000 to 1100/1250) and the gradual shift to polychrome wares (A.D. 1000/1100 to 1450) is identified in the assemblage. El Paso Polychrome, one of the more predominate nonlocal pottery types, effectively indicates a regional influence at LA 5148 post A.D. 1000. The Rio Grande valley, including the adjacent Hueco Bolson and Tularosa Basin, occur within the traditional boundary of the Jornada Mogollon region, and holds a tentative association with the Pecos River valley to the east, despite the general absence of locally made decorative pottery in the Pecos River valley. Moreover, the identification of clays and temper material, as suggested by Wiseman (Appendix K) and Hill (cf. Zamora 2000), suggest most brownware pottery was produced outside the Laguna Plata area, primarily in the Sierra Blanca region or the Rio Grande area associated with El Paso.

As discussed by Zamora (2000:70), the similarities and presence of pottery types within and between these two areas suggests populations did not exist in isolation. This construct is saliently demonstrated when more exotic pottery types are examined. The presence of pottery types northwest, far west, and far southwest of LA 5148 can best be explained through regional indirect trade and interaction rather than direct trade. The low number of any one, nonlocal pottery type, with the exception of Chupadero Black-on-white and Corona Corrugated, supports this interpretation. Not discounting direct use of the Pecos River as an access route, the general high diversity, low frequency of exotics, and distance suggests trade and exchange was indirect. Mimbres white ware dates between A.D. 750 to 1130/1150 east of the Mimbres Mountain range and overlaps chronologically with Jornada Brown, Middle Pecos Brown, South Pecos Brown, El Paso Brown, and Alma Plain; all pre-date what is considered the primary occupation at LA 5148. Chupadero Black-on-white and Three Rivers Red-on-terracotta originate northwest of LA 5148 and date post A.D. 1100, with the highest frequencies dating between A.D. 1100 and 1300. Playas Red is thought to be a product of the Casas Grande region of Mexico and also dates post-A.D. 1100 and represents a second period of intense occupation at the site.

Ceramics that date to after A.D. 1200 tend to support the traditional interpretation of site occupation at LA 5148 (Haskell 1977; Runyan 1971, 1972). St. John's Polychrome and Corona Corrugated reflect occupational events as early as A.D. 1200 and A.D. 1225, respectively. Lincoln Black-on-red, Ramos Polychrome, and Gila Polychrome indicate site use after A.D. 1300 and terminating by A.D. 1400/1450. This is slightly later that suggested by Runyan (1971) and Haskell (1977), who argued for an A.D. 1300/1350 site abandonment. The record of site activity at Laguna Plata demonstrates a consistent, although not continuous, use of the western margin of the Laguna Plata playa throughout the Formative period. The diversity in the ceramic assemblage exhibits a pattern of diachronic activity that involves regional interaction at least on a secondary level. Based on the distance to LA 5148 from points west, and the intensity in the levels of ceramic production, it may be safe to suggest the introduction of several of the pottery types may not have made their way to LA 5148 until late in the sequence or even after the terminus production event had passed.

Vessel form was used cautiously as a means to evaluate function in the absence of first order context from which the pottery was used. Using the samples of Jornada Brown, 2,106 sherds that were greater than 3 cm in diameter, were analyzed with attention directed towards two vessel forms, jars and bowls as they relate to cooking and noncooking activities. Jornada Brown, South Pecos Brown, El Paso brownware, El Paso Polychrome, Chupadero Black-on-white, and Corona Corrugated, and El Paso Polychrome, all demonstrated a predominant singular vessel form. Jars, including both neck and neckless forms represent the dominant form in the Laguna Plata assemblage. This may relate to mobility with wide-mouthed, shallow vessels associated with high mobility. Jar forms, which serve a variety of functions, probably maintained a level of occurrence for cooking and storage tasks. In contrast, most of the Mimbres white ware, Three Rivers Red-on-terracotta, Lincoln Black-on-red, and Gila Polychrome in the assemblage are bowls rather than jars.

Vessel orifices show a similar temporal trend. Orifice diameter was measured for Jornada Brown, Corona Corrugated, and El Paso Polychrome pottery types using rim sherds (n=37). The resulting data shows a temporal shift between pottery types. Jornada Brown yields a more even distribution with orifice diameter between 10 and 19.99 cm. Corona Corrugated has a skewed distribution with a range of 20–29 cm and exhibiting the highest frequency diameter. El Paso Polychrome also shows skewed distribution with most rim sherds having orifices of 10–19.99 cm. These data suggest vessel form is somewhat inconsistent through time with changes in size, form, and presumably function during the late Formative period. It is suspected that vessel form can be characterized by a variety of types, including ollas, tecomates, and bowls. Consistency is reflected in vessel form and a relative small diameter orifice, suggesting narrow jar openings were the norm rather than the exception.

14.0 Archaeofaunal Analysis

Marie E. Brown and Kenneth L. Brown

The Laguna Plata (LA 5148) archaeofaunal assemblage consists of 1863 vertebrate faunal remains, of which 1810 were recovered during the LCAS excavations and 53 (40 from testing and 13 from off-site trenching), were found during the present project (Table 14.1). ENMU conducted an initial analysis of the LCAS faunal assemblage (Gray 1977). The following is a more detailed reanalysis of the archaeofaunal assemblage and forms the basis for addressing several research questions.

- Was subsistence based partly on agriculture and partly on hunting and gathering or exclusively on one or the other?
- Are local and/or long-distance hunting discernible in the faunal assemblage and what was the importance of each?
- What resources were dietary staples?
- What butchering patterns are discernible in the faunal assemblage?
- What was the role of bison exploitation in subsistence at the site?
- Did subsistence strategies change with the availability of bison?
- Is seasonality discernible in the faunal assemblage?
- What do the lagomorph and artiodactyl indices reflect?
- Is there evidence for food stress in the faunal assemblage, such as fracturing long bones for marrow extraction and pulverizing small animals for complete consumption?

14.1 Research Methods

All of the vertebrate faunal remains recovered during the 1970–1971 LCAS excavations and present project were examined for this analysis. No sampling was conducted. In order to improve identifications and processing information, refits of old and recent breaks were determined whenever possible. In addition, all recently broken fragments from the same bone in a single provenience (bag) were counted as one specimen. These procedures reduced the sample size. Basic attributes recorded for each specimen—a complete bone or tooth or a fragment thereof—included the taxon, element, laterality (i.e., side), fragment and portion, weathering, burning, gnawing, and evidence of butchering and working. The faunal identifications were made with the aid of comparative specimens in the possession of the authors and occasionally, published osteological references were consulted.

Taxonomic identifications were made to the lowest level of specificity (e.g., order, family, genus, species) warranted by each specimen. As a result, most specimens were identified only to a size category (e.g., large bird, small mammal, large mammal). For birds, large birds are turkey-size. For mammals, small mammals are rabbit-size, medium are coyote-size, large are pronghorn-size, and very large are bison-size. Placement of a specimen into an animal size category is somewhat subjective, based primarily on the thickness of the compact (cortical) bone, the size of the specimen, and the possible element represented. In several instances, the specific taxonomic identification—genus or species—was uncertain because of the presence of two or more osteologically similar species (e.g., deer and pronghorn) in or near the project area. If the taxonomic assignment was less than certain, the modifier *cf.* (compares favorably) was used. In other cases, only the listing of alternatives (e.g., deer/pronghorn) was possible.

Table 14.1 Faunal assemblage, LA 5148

Taxon	LCAS Excavations		2010 Testing[a]	2010 Off-site Trenching		Total	
	NISP	MNI	NISP	NISP	MNI	NISP	MNI
Testudinata (Turtles)			1			**1**	
Terrapene ornata (Western Box Turtle)	22	2				**22**	**2**
Colubridae (Colubrid Snakes)	1	1				**1**	**1**
Indeterminate large bird (Turkey-size)	1	1				**1**	**1**
Leporidae (Rabbits, Hares)	37	1				**37**	**1**
Sylvilagus audubonii (Desert Cottontail)	166	10				**166**	**10**
Lepus californicus (Black-tailed Jackrabbit)	390	17				**390**	**17**
Cynomys ludovicianus (Black-tailed Prairie Dog)	17	2				**17**	**2**
Cratogeomys castanops (Yellow-faced Pocket Gopher)	8	2				**8**	**2**
Neotoma sp. (Woodrat)	1	1				**1**	**1**
cf. *Procyon lotor* (?Raccoon)	1	1				**1**	**1**
Odocoileus sp. (Deer)	8	2				**8**	**2**
Antilocapra americana (Pronghorn)	129	6	2			**131**	**6**
cf. *Antilocapra americana* (?Pronghorn)	6					**6**	
Odocoileus/Antilocapra americana (Deer/ Pronghorn)	66					**66**	
Bison bison (Bison)	3	1		3	1	**6**	**2**
cf. *Bison bison* (?Bison)	8			2		**10**	
Indeterminate small mammal (rabbit-size)	260		21			**281**	
Indeterminate medium mammal (coyote-size)	18		13			**31**	
Indeterminate large mammal (pronghorn-size)	624		3	1		**628**	
Indeterminate very large mammal (bison-size)	44			7		**51**	
Total	**1810**	**47**	**40**	**13**	**1**	**1863**	**48**

[a]within LCAS features, therefore, no MNIs calculated
NISP = number of identified specimens
MNI = minimum number of individuals

After the variables were recorded, the number of identified specimens (NISP) was computed for each taxon and the minimum number of individuals (MNIs) was calculated for each identified species or genus. The type of MNI presented in Table 14.1 is the minimum kind. This type considers the site's assemblage as a whole and assumes that all specimens of a specific taxon could represent the same individual, regardless of provenience. As a result, the calculation of MNIs only considered taxon, element, side, portion, and age, which was based on the degree of bone fusion and porosity—overall ossification—of bone specimens. The bones of very young mammals are distinctly spongier—less ossified—than those of adults. The NISP and MNI values form the basis for the faunal assemblage descriptions and interpretations. Because they are not from the site per se, NISPs and MNIs were calculated separately for the faunal remains recovered from the off-site trenching during the present project (Table 14.1).

The interpretation of any faunal assemblage is subject to several sources of probable bias. First, because of preservation factors and excavation techniques, it is impossible to recover every bone originally deposited in a site. An excavated assemblage, therefore, is by very nature a sample. In addition, it is a sample of a sample because few sites, if any, are excavated in total. Depending on where excavations occurred within a site—such as in structures, middens, refuse disposal areas, and activity areas—analysis of the recovered faunal remains can produce varying or conflicting interpretations. Sample size is another potential source of bias, particularly in smaller site assemblage. As stated by Grayson (1984:117), "extremely small samples probably do not provide an adequate base from which statistical inferences concerning relative abundances within the target population can be made." (The target population is the animal set exploited by a group of people [Grayson 1984:116].) Sample size is also subject to other biases.

Relative taxonomic abundances may be significantly correlated with the size of the samples from which they have been determined. Consequently, interpretations of relative abundances may prove to be primarily interpretations of the size of the samples from which the abundances have been derived (Grayson 1984:129). One measure of taxonomic abundance is richness. This refers to the number of taxa (species) that have contributed to a faunal assemblage (Cruz-Uribe 1988:180; Grayson 1984; Leonard 1989:23). Another measure sometimes used to ascertain taxonomic abundance is general diversity, which takes into account both the number of taxa present (richness) and the relative frequency of each taxon (Cruz-Uribe 1988:179). Some researchers (e.g., Grayson 1984:138–149; Leonard 1989; Leonard and Jones 1989; Meltzer et al. 1992) have shown strong correlations between richness and sample size as measured by NISP.

In the present analysis, interpretations are based on NISP, MNI, and relative percentages. The MNI is the number of animals of an identified taxon necessary to account for all the recovered bones of that taxon (Shotwell 1955:330). Although used by American paleontologists as early as the 1920s (see Grayson 1973:433, 1984:27–28), the method for determining MNI was introduced into American archaeology by White (1953). Improvements of White's technique have occurred over the years (Bökönyi 1970; Chaplin 1971; Grayson 1973, 1979, 1984). The different methods utilized for determining MNI, however, can yield varying results for the same assemblage (see Casteel 1977a, 1977b; Grayson 1973, 1978, 1979, 1984; Horton 1984; Ringrose 1993:126–128). As a result, some researchers see little value in the use of MNI (e.g., Casteel 1977b; Turner 1980). As suggested by Horton (1984:255), "there is no single 'best' method, since the one that is chosen depends upon the result desired, and on the particular features of the site and excavation." With these drawbacks in mind, MNI values are presented as a quantitative counterbalance to the NISP values. It is a means of standardizing the data. In addition, MNI values are used herein because they are relatively unaffected by differential fragmentation among species and samples and are, therefore, better for assuring comparability among indices computed for different samples (Cruz-Uribe 1988:180; Klein and Cruz-Uribe 1984). In addition, not all levels of aggregation to obtain MNI values are likely to be sensible according to site contexts and research questions. The problem of aggregation, therefore, is probably not as great as Grayson (1984) suggests (Ringrose 1993:128).

Not all recovered vertebrate archaeofaunal remains from a site are cultural. Although some researchers base intrusiveness on the presence of partial or nearly complete skeletons of animals such as small rodents (Thomas 1971; Ziegler 1973), analysts also must consider the taphonomic factors affecting the differential preservation of bones (Lyman 1984) as well as recovery techniques. Szuter (1989:209–219) presents five pieces of evidence for interpreting rodent bones. Three of these criteria are used in varying degrees in this analysis: (1) Southwestern ethnographic accounts, (2) ecological studies, and (3) archaeological evidence (including context and condition of the bones).

As indicated by the research questions, elucidation of subsistence patterns is a major focus of this analysis. Subsistence systems involve at a minimum the interaction of humans, technology, and floral and faunal resources. The study of these interactions through time and across space provides a description and an understanding of various lifeways (Lyman 1982:331). A subsistence study, therefore, requires consideration of more than just the animals. It is intimately involved with the interaction of humans—including their technology and adaptive exploitative strategies—and animals with the environment and with each other. Several diverse but related fields of research are used, including ethnography, environmental science, cultural ecology, and animal ecology.

14.2 Natural History and Ethnographic Background

The following are brief descriptions of the natural history of taxa identified to the level of genus or species within the faunal assemblage (Table14.1). If available, ethnographic data are presented for these taxa, These data are derived from a variety of North American Indian groups, not only those of the Southwest, and are not intended to suggest exact usage by the Native American inhabitants of the project area. Rather, they serve as examples of why and how the identified taxa may have been exploited.

14.2.1 Reptilia — Reptiles

14.2.1.1 Terrapene ornata (Western Box Turtle)

The western box turtle (*Terrapene ornata*) is native to the project area and is represented in the Laguna Plata archaeofaunal assemblage by 22 carapace and plastron specimens. This turtle, which attains a length of 10–15 cm, is a terrestrial species that can enclose itself within its shell. It prefers dry, open grasslands, seldom entering wooded areas. Although not dependent on surface water, the box turtle may enter shallow pools during hot weather. It hibernates in the ground during the winter. Burrows can reach depths of 61 cm in open grasslands but are shallower in woodlands. This species has a population density of more than one individual per acre. A clutch of two to eight eggs is laid in late spring to early summer. The box turtle is omnivorous. Its diet consists of insects, earthworms, vegetation, and carrion (Collins 1974:95–98; Degenhardt and Christiansen 1974:30–33; Degenhardt et al. 1996:104–107; Ernst and Barbour 1972:96–102; Williamson et al. 1994:134). Although the box turtle is sometimes eaten, it is believed to be a source of illness (Ernst and Barbour 1972:95).

Turtles were consumed as dietary supplements by various groups, especially during times of food stress. Although not considered particularly desirable, the Mescalero ate turtles during times of food scarcity (Basehart 1960:27–28). The type of turtle—terrestrial or aquatic—is not specified. Box turtles may have been easy to procure by simply picking them up when seen. After killing the turtles with a stone, the Miwok roasted the turtles in ashes until they split open. Then the intestines were removed (Barrett and Gifford 1933:139). The Pawnee made turtle soup (Weltfish 1977:231). After first killing the turtles by putting their heads in a fire, the Cheyenne eviscerated them while they were still in their shells. “Then a large fire was built, and the turtles were placed about it, standing up on the edges of their shells and thus roasted. Some people boiled the turtles in their shells” (Grinnell 1923:I:308). The Florida Seminole usually did not kill the turtles prior to preparation for consumption. “They merely cut off the plastron and butcher the animal alive and kicking, when it is set up before the fire and roasted in its own oven” (Skinner 1913:77). In addition, Southeastern groups ate turtle eggs (Swanton 1946:298).

Besides consumption as food, turtles have also been used as a raw material source for utilitarian and ceremonial objects and ornaments, such as carapace bowls and rattles, by a variety of peoples. The Hopi, one of many groups that used turtle shells as dance rattles, killed the turtles to be used as rattles

> By cutting the skin away from the shell and drawing the body out of the shell by the neck. The body was thrown back into the water in the belief that it would grow a new shell and so be caught again on another occasion.…The shells were brought back to the village and hung up to dry in the sun, being tested at intervals by flicking with the forefinger to determine the amount of drying advisable to produce the maximum sound. Sheep’s hooves were tied to the shells to produce the completed rattle [Beaglehole 1936:23].

The Menomini often tipped arrows for use in battle with turtle claws (Skinner 1921:322). Similar uses, however, were not discerned among the turtle remains in the Laguna Plata archaeofaunal assemblage.

14.2.2 Mammalia — Mammals

14.2.2.1 Sylvilagus audubonii (Desert Cottontail)

Of the three cottontail species known in New Mexico, the desert cottontail (*Sylvilagus audubonii*) is the most widespread, occurring throughout the state (Bailey 1931:54; Cockrum 1982:133; Findley et al. 1975:89). This leporid, which is represented in the archaeofaunal assemblage by 166 specimens, is found primarily at elevations below the coniferous forests, in the Lower and Upper Sonoran zones. It inhabits deserts, grasslands, brushy areas, piñon-juniper woodlands, and riparian zones. The desert cottontail also frequents cultivated fields and the dense vegetation adjoining such fields. Brush or shrubs are necessary for resting and hiding (Bailey 1931:54–60; Chapman and Willner 1978:2–3; Clark and Stromberg 1987:80; Findley 1987:57; Zeveloff 1988:92). This cottontail is normally active early in the morning and at night and subsists mainly on grasses, forbs, cacti, and shrubs (Bailey 1931:55–56; Chapman et al. 1982:102; Chapman and Willner 1978:3). Cultivated plants, including corn, are also eaten (Bailey 1931:55–56; Chapman et al. 1982:101). Much of the cottontail's water requirements are provided by its food (Bailey 1923:71–72; Chapman et al. 1982:102; Findley 1987:57; Zeveloff 1988:92).

Predation by a variety of animals—bobcats, coyotes, foxes, raccoons, skunks, raptors, snakes—is the major cause of cottontail deaths and it is the primary regulator of cottontail abundance (Chapman et al. 1982:106–107; Clark and Stromberg 1987:78–79; Ingles 1941:236; Zeveloff 1988:88, 92). The cottontail, however, is an r-selected mammal. Its high mortality rate is offset by a high reproductive rate. Breeding generally occurs from mid- or late winter through late summer. A single female may have as many as six litters of usually three to six individuals per year. The first and last litters of the year tend to be smaller. Female desert cottontail born in the spring are capable of breeding during their first summer, offsetting their low litter sizes (Chapman et al. 1982:94; Clark and Stromberg 1987:78, 81; Findley 1987:57–58; Hoffmeister 1986:131, 137; Zeveloff 1988:93).

Many peoples, such as the Jicarilla Apache (Opler 1936:207), Navajo (Hill 1938:171), Hopi (Beaglehole 1936:11–15), Havasupai (Spier 1928:108), Yavapai (Gifford 1932:205, 1936:266), Omaha (Fletcher and La Flesche 1911:104), Chippewa (Densmore 1929:44), and Kiliwa (Michelsen 1967), hunted cottontail for food and other purposes. Cottontail were killed incidentally during communal jackrabbit hunts or drives. Because of their behavior, cottontail could be procured successfully by individual hunters. These leporids usually do not venture far from cover and when alarmed, they seek shelter in brush or in burrows. Other escape behaviors consist of "freezing" (remaining motionless) and running and dodging (Ingles 1941:237–238, 249). Because cottontail "travel along open, well-defined routes" (Chapman et al. 1982:116), "wearing trails or runways in the vegetation, snow, or under brush piles" (Schwartz and Schwartz 1981:104), they are easy to find. In addition, cottontail do not run as fast, or as far, as jackrabbits. All these factors make it easier for individual hunters to procure cottontail by simple devices such as snares, traps, bow and arrows, throwing sticks, and guns.

Basin-Plateau groups used snares, and bows and arrows to procure cottontails (Steward 1938:39). The Sanpoil also killed rabbits with bows and arrows (Ray 1932:87), and the Omaha used headless arrows with sharpened shafts (Fletcher and La Flesche 1911:451). The Hopi used deadfalls and snares (Beaglehole 1936:17). Plains Cree used several types of snares, including a noose suspended from a tree. The rabbit had to put its head through the noose to reach the bait because a fence of small sticks around the snare made this the only way to reach the bait. Another snare type, a spring snare, was attached to a sapling that had been bent down. A third type of snare "consisted of a forked stick planted fork down in the ground. The noose was attached to the two arms of the fork with strands of grass. Beaters went over a tract of land and the running rabbits plunged through the nooses and were held fast" (Mandelbaum 1940:199). Among the northern Shoshone, boys hunted cottontail with dogs (Lowie 1909:185). When a rabbit was found hiding in a rotten log, the Wind River Shoshone "plugged up the hole with sagebrush and started a fire, fanning the smoke into the log" (Lowie 1924:199). The plug prevented the animal from escaping and after it stopped making noise, "the hole was uncovered and the dead rabbit was pulled out" (Lowie 1924:199).

The Chiricahua Apache and other groups dislodged rabbits from burrows with long sticks. An end was twisted into the fur and then, the animal was pulled out (Opler 1941:326). Before thrusting the stick into the hole, the Navajo pointed and abraded one end so it would catch in the fur easier. If the burrow had two openings, however, the Navajo built a fire in one and smoked out the animal. Cottontail caught in jackrabbit drives were clubbed (Hill 1938:171). The Miwok caught cottontail with nets and then broke the necks of the entangled animals. During the winter, they tracked cottontail in the snow and killed them with clubs (Barrett and Gifford 1933:182). The Yavapai shot rabbits with bows and arrows or used straight or curved throwing sticks. They also surrounded rabbits with fire and then clubbed them. As done by other groups, the Yavapai used sticks to extract rabbits from burrows. Occasionally, they used spring traps or decoyed the animals with a rabbit call made with a finger against one side of the mouth (Gifford 1932:216–217. 1936:266). The Tepehuan caught rabbits by means of many of the above methods or variations thereof (Pennington 1969:123).

After skinning and eviscerating the cottontails, the Tepehuan either roasted them on spits or boiled them (Pennington 1969:123). After removal of the skin and internal organs, the Pomo pounded the carcasses to a pulp, reducing the bones to small fragments that were easily consumed with the broiled meat (Barrett 1952:63). Before cooking the cottontail in hot ashes, the Shoshone skinned and cleaned them (Lowie 1924:197). Although the Havasupai usually roasted rabbits in ashes, they may also have used roasting pits (Spier 1928:117). The Yavapai either cooked rabbits in ashes or boiled them in pots. In addition, they preserved rabbit meat for several days by skinning the rabbits, slightly charring the carcasses, and then hanging them up. The bones were not cracked for marrow extraction (Gifford 1932:205, 1936:266). The Chippewa prepared the carcasses two ways:

> (a) The meat was removed from the bones, roasted, and pounded. The bones were then pounded with what meat remained on them. The pounded bones were boiled in a small kettle and the grease skimmed off and eaten with the pounded meat.
>
> (b) The meat was cut in pieces and dried, the bones being dried also. The bones were pounded to a powder and mixed with the dry meat and any available grease. This was eaten dry, and not boiled at the time of using [Densmore 1929:44].

Various groups also procured cottontail for nonsubsistence uses. Caddo women used rabbit skins dyed red for tying their hair behind their heads (Hatcher 1927:177). The Sanpoil used rabbit fur for caps, mittens, and blankets (Ray 1932:87). The Yavapai (Gifford 1936:272), Ute (Lowie 1924:216), and Plains Cree (Mandelbaum 1940:214) made rabbit skin blankets to wear as robes and/or use as bedding. Although many peoples only made rabbit skin robes with jackrabbit skins, some groups, such as the Havasupai (Spier 1928:188, 190) and Shoshone (Lowie 1924:216), also used cottontail skins. The Yavapai used rabbit brains to dress skins (Gifford 1932:222). The Havasupai played the cup-and-pin game with either a cottontail or jackrabbit skull (Spier 1928:340).

14.2.2.2 Lepus californicus (Black-tailed Jackrabbit)

Most of the archaeofaunal remains identified to genus or species are those of the black-tailed jackrabbit (*Lepus californicus*) (n=390), the most common jackrabbit in New Mexico. It occurs throughout the state below the ponderosa forest zone (Findley 1987:55; Findley et al. 1975:93–94). This leporid is usually found at elevations below 1,800 m (6,000 ft), in the Lower and Upper Sonoran zones (Bailey 1913:18, 33, 1931:48). It inhabits deserts and open shortgrass prairies with scattered shrubs. In addition, the jackrabbit is very adaptable to agricultural conditions. Areas of heavy brush or woods are avoided (Dunn et al. 1982:133; Findley 1987:54–55; Findley et al. 1975:93–94, Hoffmeister 1986:140–141; Zeveloff 1988:98). "They are found in mesquite, sagebrush, desertscrub, into open pinyon-juniper" (Hoffmeister 1986:141). The black-tailed jackrabbit is most common, however, in open, treeless habitats (Findley 1987:55).

The jackrabbit usually feeds at night on grasses, mesquite, herbs, and cultivated crops. Like the cottontail, the jackrabbit also obtains protein and certain B vitamins by consuming its soft droppings. Although this leporid depends on succulent or green vegetation for water, it drinks surface water when available. Daylight hours are usually spent in its form, an unlined hollow scratched into the ground. Forms are found both in the open and in dense vegetation. The breeding season extends from mid- or late winter to late summer. A single female may have as many as seven litters of two to four individuals per year. Because the black-tailed jackrabbit is an r-selected species, the yearly number and size of litters per breeding female help to offset the high mortality rates. Jackrabbit predators include snakes, eagles, hawks, owls, coyotes, foxes, bobcats and skunks (Clark and Stromberg 1987:84–87; Dunn et al. 1982; Findley 1987:56; Hoffmeister 1986:141–142; Zeveloff 1988:84, 99–100).

Although some people consider jackrabbit flesh unpalatable or inferior to cottontail (e.g., Buskirk 1986:134; Castetter and Opler 1936:25; Dunn et al. 1982:137; Opler 1941:325–326; Texas Game, Fish and Oyster Commission 1945:133–134), ethnographic data indicate many groups exploited jackrabbits as food resources and as raw material sources (e.g., see Beaglehole 1936:11–17; Fletcher and La Flesche 1911:104; Gifford 1932:205, 222, 226, 1936:266, 272, 299; Grinnell 1923:I:247, 1923:II:218, 269; Hill 1938:170–171; Michelsen 1967:77; Ruecking 1953:481; Spier 1928:108; Steward 1938:38–39). Jackrabbit behavior is ideal for communal hunts and drives. When alarmed, the jackrabbit may remain motionless or run away slowly or very rapidly. It can attain speeds of 30–35 miles per hour over short distances. A jump normally covers 1.5–3 m (5–10 ft), but increases to 4.6–6 m (15–20 ft) when the animal is speeding. It can jump as high as 1.7 m (5.5 ft) (Dunn et al. 1982:134; Findley 1987:56; Schwartz and Schwartz 1981:119). Consequently, hunting the jackrabbit with a bow and arrow is difficult. Communal efforts are more efficient.

Although the Hopi held communal rabbit hunts at irregular intervals throughout the year, such hunts usually occurred in early summer and fall when the crops needed protection from the rabbits or when rabbits were needed to feed captive eagles. The hunters formed a two-winged circle, and as they walked toward the center, they flushed the rabbits from the bushes and killed them with curved or straight, pointed throwing sticks (Beaglehole 1936:11–17). The Navajo clubbed the jackrabbits as they tried to escape the encircled area. Although the Navajo did not use nets and corrals when hunting rabbits, they used fire occasionally. After encircling the animals with fire, they were clubbed to death as the fire closed in on them (Hill 1938:170–171). The Jicarilla Apache caught jackrabbits with snares (Opler 1936:207). Basin-Plateau groups also used fire surrounds, but not very often "because desert shrubs are usually too widely spaced for a fire to spread" (Steward 1938:39). Instead, jackrabbits were driven into a large semicircular arrangement of long, low nets where the animals were killed with sticks or bows and arrows (Steward 1938:38–39). After driving them into huge nets, as much as 91 m (300 ft) long, the Paiute shot the rabbits with arrows (Lowie 1924:196–197). The Havasupai did not encircle the rabbits. Instead, they used a straight formation to drive the animals, which were then shot, never clubbed (Spier 1928:112). Communal hunts could last from several days to as much as a month (Lowie 1924:196–198; Steward 1938:97). Western farmers used large rabbit drives in the late 1800s to control jackrabbit populations (Dunn et al. 1982:138) because jackrabbits "tend to graze forage more severely than cattle" (Findley 1987:56).

After the Hopi skinned and dressed the rabbits, they cooked the meat in a pot with corn and squash (Beaglehole 1936:14). The Havasupai roasted rabbits in ashes and possibly in roasting pits (Spier 1928:117). Shoshonean groups used several methods for cooking rabbits—hot ashes and watertight baskets into which hot stones were placed to heat the contents. Some Shoshonean groups pounded the bones very fine and consumed them with the meat (Lowie 1924:196–197, 233). The Kiliwa also pulverized the bones. After removing the ribs, they ground the cooked jackrabbit spine in a small, shallow mortar until it had the consistency of thick paste, to which they added salt and then consumed it. The Kiliwa also pounded jackrabbit carcasses on metates (Michelsen 1967:76–77).

Most of the aforementioned groups made rabbit skin robes and/or blankets. Because construction techniques were similar, only that of the Plains Cree is presented:

> A rabbit was flayed by breaking through the skin at the tendons of the hind legs and the whole hide peeled back over the head. The hide was then cut in one continuous strip, three or four inches wide, and hung to dry for two days. It soon curled so that the fur was outermost on all sides. Four poles were lashed together to make a rectangular frame. A strip of hide was laced to the top of the frame and a line of perforations punched along its length. Similar strips were attached to the two vertical sides of the frame. The initial strand of fur was passed in and out of the top holes and then through one hole on the side strip where it was looped back on itself. … The "simple loop" netting technique was used. When one strand ran out, another was knotted to it [Mandelbaum 1940:214].

Jackrabbits also had other nonsubsistence uses. Some northern Shoshone men wore rabbit skin caps with several rabbit tails attached (Lowie 1909:161). Havasupai women sometimes used jackrabbit leg bone tubes as rattles on their belts (Spier 1928:188). A special whistle, made from the femur of a jackrabbit killed by an eagle, summoned eagles during the Navajo Bead Way and Eagle Way chants (Kluckhohn and Wyman 1940:33). The Miwok also fashioned whistles from jackrabbit limb bones (Barrett and Gifford 1933:214). The cup-and-pin game of the Havasupai used the jackrabbit skull:

> The cup and pin game…consists of a cotton-tail or jack-rabbit skull fastened to a sharply pointed twig, about 8 cm long, by a slightly longer cord.…The base of the skull is cut away, the teeth drawn, and it is boiled free of meat. The cord is tied back of the incisors. Holding the stick, the skull is swung toward the body and caught on the point. Catching by any hole scores one; any tooth hole, six; ear hole (?), ten; incisor hole, forty; and if the stick splits off in a foramen palatinum, the game is won.…Three hundred or more counters are made of soapweed leaves split into narrow pieces, 10 cm long…The side getting all the counters wins [Spier 1928:340–341].

14.2.2.3 Cynomys ludovicianus (Black-tailed Prairie Dog)

Few remains of the black-tailed prairie dog (*Cynomys ludovicianus*) (n=17) were recovered from LA 5148. Today, this species is found in the eastern half of New Mexico, but its range formerly extended into the southwestern portion of the state (Bailey 1931:120; Findley 1987:67; Findley et al. 1975:130–131). The black-tailed prairie dog is primarily an Upper Sonoran species (Bailey 1913:32, 1931:120, 123) that inhabits semi-arid shortgrass prairies, avoiding stands of tall grass. It is a highly social animal that lives in very large colonies that can extend over large expanses of plains. Family groups retain some cohesion and independence within the well-organized colonies. Communication among colony members is both vocal and visual. A dome- or doughnut-shaped mound surrounds the burrow entrance, which may extend almost vertically to a depth of 5 m before leveling off. The entrance mound prevents water from entering the burrow. The burrow system is extensive and permanent. The nest is in the deeper portion of the burrow. Much of the winter is spent in the burrow. Breeding occurs in late winter and a single litter of about four young is born in late March or early April. This prairie dog consumes the stems, leaves, and seeds of a variety of grasses, weeds, and shrubs. The black-footed ferret (*Mustela nigripes*), a presently endangered species, was the most specialized predator of the black-tailed prairie dog. Formerly, both species had nearly identical distributions. Other predators include hawks, weasels, coyotes, foxes, bobcats, badgers, and snakes (Findley 1987:67–68; Hoffmeister 1986:194–196; Zeveloff 1988:145, 147). The burrowing activities of prairie dogs can severely impact buried cultural deposits if their colonies are established in a buried site.

Prairie dogs are considered food competitors of domestic livestock. Much effort, therefore, has been devoted to eradicating them from rangeland. Such programs have primarily used poisons. As a result, prairie dogs are extinct within many areas of their former range (Findley 1987:68).

The Hopi used (and perhaps still use) deadfalls and snares to catch prairie dogs (Beaglehole 1936:17). Northern Shoshone boys used dogs to hunt prairie dogs (Lowie 1909:185). The Navajo dug or drowned prairie dogs out of their burrows or shot them with bows and arrows.

> Special arrows were used in hunting prairie dogs. These were unfeathered and the points had only one barb. (Formerly when arrow points were found, one barb was broken off, or bone points of this pattern were made. With the introduction of iron, points of the same type were hammered out) [Hill 1938:171].

The Navajo also used a piece of mica, placed on a split stick, to blind a prairie dog as it emerged from its burrow. It was then shot and pulled out with a barbed arrow.

> After heavy rains, flood waters were directed into holes to drown out the prairie dogs.… Water was also carried to the holes for this purpose. The hole was first plugged with manure and grass, and a basin built around it. When the basin was filled, the plug was removed, allowing a large volume of water to descend into the hole at one time [Hill 1938:172].

If several frightened prairie dogs ran into the same hole, the Navajo dug them out with a digging stick. The Navajo also trapped these animals by placing nooses attached to a rock or stake at burrow entrances (Hill 1938:172). Basin-Plateau groups used similar methods. "They [prairie dogs] were either dug with a digging stick, pulled from their burrows by means of a rodent skewer, smoked out, flooded out, or killed with deadfall traps" (Steward 1938:40). The Yavapai caught prairie dogs in stone deadfall traps (Gifford 1936:266).

The Navajo generally used only one method for cooking prairie dogs. After the carcass was cleaned, the liver, lungs, and fat were placed in the body cavity and it was salted. The opening was pinned closed with twigs. "Then the hair was singed in an open fire and the animal buried in the ashes to roast" (Hill 1938:172). The Yavapai cooked prairie dogs in hot ashes after first cleaning and skinning them (Gifford 1936:266). The flesh is reportedly very greasy (Elmore 1938:152).

14.2.2.4 Cratogeomys castanops (Yellow-faced Pocket Gopher)

The range of the yellow-faced pocket gopher (*Cratogeomys castanops*), which is represented by eight specimens, includes the project area. In areas of overlap with the Plains pocket gopher (*Geomys bursarius*), the yellow-faced pocket gopher, a moderately large gopher, occupies the harder, shallower soils of the interfluves, while the Plains pocket gopher is most common in the soft alluvial soils of floodplains and arroyo bottoms. When not competing with the Plains pocket gopher, the yellow-faced pocket gopher prefers deep, friable soils relatively free from rocks (Davis and Schmidly 1994:130–131; Findley et al. 1975:152; Fitzgerald et al. 1994:209). The yellow-faced pocket gopher primarily subsists on roots and stems, including the outer bark on tree roots, and it also consumes crops—alfalfa, clover, and garden vegetables (Davis and Schmidly 1994:131; Fitzgerald et al. 1994:209). "The animals harvest materials either from within the tunnel system by pulling plant roots and shoots down through the soil or by venturing out above ground to forage" (Fitzgerald et al. 1994:209). Breeding occurs from February through August. One or two litters of mainly two or three young are born in fur- or grass-lined nests deep within the burrow. The nest may be as much as 1.6 m deep. Major predators consist of owls, hawks, snakes, badgers, weasels, bobcats, foxes, and coyotes (Chase et al. 1982:250; Davis and Schmidly 1994:131; Findley 1987:75–76; Fitzgerald et al. 1994:210).

The pocket gopher is a highly fossorial rodent that lives a solitary life almost entirely underground. Depending on soil conditions, burrow systems can vary from less than 30 cm to more than 1 m in depth (Hoffmeister 1986:224). In clayey soil, tunnels and mounds are smaller than in sandy soil (Davis and Schmidly 1994:130). In general, burrow systems consist of a shallow network of foraging tunnels and a deeper network containing food stores and the nest chamber (Fitzgerald et al. 1994:209). The main tunnel has been measured to depths of 1.5 m below the surface (Felthauser and McInroy 1983:557). Feeding tunnels parallel the surface and average between 10 and 30 cm deep. During winter, pocket gophers burrow through snow, depositing soil excavated from their underground burrows in the snow tunnels (Chase et al. 1982:246; Findley 1987:75; Hoffmeister 1986:225; Zeveloff 1988:161, 165). Pocket gophers mix and deepen the soil, and a single individual can displace one to three tons or more of soil annually (Kennerly 1964:428; Richens 1966:533). Thus, the impact of faunalturbation on the cultural deposits of archaeological sites containing remains of this burrower can be considerable. Several researchers (e.g., Bocek 1986, 1992; Erlandson 1984; Johnson 1989) have studied the effects of pocket gopher burrowing activities on the distribution of archaeological materials.

Ethnographic data indicate several groups ate pocket gophers, including the Gosiute Shoshone (Steward 1938:138–139), Navajo (Hill 1938:172), Tepehuan (Pennington 1969:124–125), and Plains Cree (Mandlebaum 1940:199). Basin-Plateau groups caught pocket gophers by pouring water into the burrows and capturing the animals as they tried to escape. They used digging sticks or rodent skewers to remove them from their burrows, and they also smoked them out. Outside the burrows, the pocket gophers were killed with deadfall traps or were run down and dispatched with sticks and stones (Steward 1938:40). The Plains Cree caught gophers with snares. “A sinew noose was placed over a gopher’s hole. The other end of the line was held by the snarer. When a gopher appeared the line was jerked tight” (Mandelbaum 1940:199). The Gros Ventre used a similar technique (Kroeber 1908:149).

After the gophers were skinned and cleaned, the Gosiute Shoshone dried the meat without removing the bones (Steward 1938:130). The Tepehuan skinned and cleaned the gophers before they were either roasted on a spit or boiled with other meat (Pennington 1969:125). The rodents also had nonfood functions. The Navajo drank a mixture of water and a gopher stomach and flesh as a stomach ache remedy (Hill 1938:172). Such usage, however, is invisible in the archaeological record.

14.2.2.5 Neotoma sp. (Woodrat)

The woodrat (*Neotoma* sp.) is represented by a single specimen. The site is within or near the range of two woodrat species—the Southern Plains woodrat (*Neotoma micropus*) and the white-throated woodrat (*N. albigula*). Each tends to occupy different habitats. The Southern Plains woodrat is primarily a Lower Sonoran (Bailey 1913:18, 1931:171) grassland species that tends to avoid rocky areas. It prefers xeric or semi-arid regions with thickets of cacti, mesquite, and thornbush. Houses are constructed of sticks and spiny vegetation in the midst of cacti or thorny bushes. Oftentimes, an underground burrow system is dug. These construction methods provide protection from larger animals. Openings, at least two, near the base of the house are indicated by well-worn trails leading to them. The diet of this woodrat consists mainly of the flesh and fruit of cacti; however, mesquite beans and pods, fruit, seeds, and a variety of green vegetation are also consumed. Water requirements are supplied by the food eaten. Breeding generally occurs from mid- or late winter until late summer. A female may have two or more litters per year. Although litters may consist of as many as six young, the usual number is two to four. Major predators include bobcats, ringtails, foxes, coyotes, hawks, and owls (Bailey 1931:171–174; Davis 1974:218–219; Findley 1987:98–100; Findley et al. 1975:238–240).

The white-throated woodrat primarily an Upper Sonoran species (Bailey 1913:32, 1931:175), occurs in a variety of habitats, usually below the conifer zone. It is frequently found in piñon-juniper and is common in extensive cholla and prickly pear cactus areas. Cacti provide food and water, protection for the nest, and function as anchors for the houses. Rocky areas are also selected as house sites. Mesquite, herbs, and shrubby vegetation supply additional food. Cactus joints, sticks, thorns, and other available materials are used to construct the houses that average about 2.5 m in diameter and about 1 m high. The nest, which is partially dug into the ground below the house, is usually constructed of grasses and is about 20 cm in diameter. It is used as a daytime retreat, and to raise the young. A female may have more than one litter, usually consisting of two to four young, per year. Major predators include owls, snakes, ringtails, coyotes, badgers, bobcats, and weasels (Bailey 1931:175–180; Cockrum 1982:114–115; Davis 1974:221; Findley 1987:97–100; Findley et al. 1975:241–242; Hoffmeister 1986:406–407; Zeveloff 1988:209–210).

The woodrat is often called a "pack rat" from its habit of collecting all sorts of objects, both cultural and noncultural, and incorporating them into the den or nest. This rodent can disturb the artifact distribution patterns of a site and/or create pseudo-features (Hester and Hill 1980; Hoffman and Hays 1987). Burned woodrat houses, including contents, look suspiciously like prehistoric hearths (Hester and Hill 1980). Therefore, woodrats are a potential agent of faunalturbation at sites in which their bones are found. However, the presence of woodrat bones in a site's faunal assemblage is not necessarily indicative of intrusion. As suggested by ethnographic data, the woodrat was exploited by several groups.

The Jicarilla Apache (Opler 1936:207), Navajo (Bailey 1931:185; Hill 1938:173), Walapai (McGuire 1983:32), Basin-Plateau groups (Steward 1938:40, 83, 158), Kiliwa (Michelsen 1967:74), Yavapai (Gifford 1932:205, 1936:266), and Chiricahua Apache (Opler 1941:325) are among those groups that ate woodrats. This rodent was a staple in the diet of peoples in southern Texas (Hester and Hill 1980:318). Ethnographic literature also indicates the Omaha (Fletcher and La Flesche 1911:104) and Tonkawa (Newcomb 1961:139) consumed unspecified rats (possibly woodrats). The flesh of this rodent has been described as "tender, sweet, and delicious as young rabbit or quail" (Bailey 1931:180).

Basin-Plateau groups used woodrat hunting techniques similar to those for ground squirrels and prairie dogs (Steward 1938:40). The Navajo killed woodrats after digging them from their nests (Hill 1938:173). The Chiricahua worked in pairs when procuring woodrats. While one hunter poked a stick into a nest opening, the other hunter waited for the prey at the other opening. When it came out, it was shot with a headless arrow that had a sharpened shaft. Sometimes the woodrats were hit with a stick when they tried to escape from the nest (Opler 1941:325). The Hopi utilized deadfalls and snares to catch rats (Beaglehole 1936:17). The Kiliwa poked a pole into the nest. When the frightened animal attempted to flee, it was stamped by a hunting companion's feet, killed with rocks, or shot with an arrow. If the woodrat refused to emerge, the nest was burned (Michelsen 1967:75). The Walapai used a hooked stick to remove woodrats from their nests (McGuire 1983:32). The Yavapai had several methods for procuring woodrats. Stone deadfall traps were used. Woodrat nests in cacti or bushes were pulled apart with the curved end of 6 to 8-ft sticks. The rats were killed as they tried to escape. In addition, the hunters took the piñon nuts stored in the nests. Woodrats were also forced from their nests by poking the straight end of the long sticks into their nests. The woodrats were killed with bows and arrows or with sticks. If a hunter seized one by its neck with his bare hands, the rodent was struck against the rocks to kill it (Gifford 1932:217, 1936:266). The Tepehuan trapped woodrats with an inverted, tilted earthenware bowl "supported by a figure-four release mechanism and baited with a few grains of corn or wheat (Pennington 1969:125).

Michelsen (1967:76) provides a detailed description of the preparation of a woodrat for consumption by the Kiliwa:

> Preparations for eating are quick and efficient. First a fire is built of small branches.. While the flames are high the whole animal is tossed into the fire. When the hair is well singed the rat is removed with a pair of sticks, used as tongs, and placed on a branch of fresh juniper or some similar evergreen. The skin, partially cooked, slips off cleanly and easily. The entrails are removed and the rat laid on the green boughs. After the flames of the fire have died down sufficiently the carcass is placed on the coals to roast for 10 or 15 minutes.

> The most remarkable part of the procedure takes place after the meat is cooked. The legs are pulled off and nibbled in the classic manner. However, the rib cage, spine and pelvis are placed on a flat rock, sometimes a metate, and thoroughly crushed with a hammerstone. The carcass, well shredded, is then eaten, bones and all [Michelsen 1967:76].

After singing off the fur, Great Basin groups pit-roasted woodrats whole or eviscerated them and stuffed them with wild onions (Fowler 1986:82). The Yavapai prepared woodrats for consumption in several ways. They either boiled them whole or with the intestine removed. After skinning and eviscerating the woodrats, the Yavapai placed the skin in the abdominal cavity and baked the carcass under ashes. The skin was consumed as a delicacy. In addition, woodrats were preserved for short periods for later consumption. In that case, they were slightly charred after skinning and were hung in the hut in bundles of 20 or 30. They could be kept this way for a few days, and when they were to be eaten, they were boiled (Gifford 1936:266). After skinning and cleaning the woodrats, the Tepehuan roasted them either on a spit or over coals (Pennington 1969:125). The Navajo frequently ate woodrats in the early days and either baked the meat on live coals or boiled it (Elmore 1938:153).

Woodrats had other cultural uses. The Navajo sometimes used woodrat fur in incense (Hill 1938:173). A Pawnee subsistence strategy indirectly exploited woodrats. In the fall, women collected part of these rodents' wild bean and potato hoards, leaving a portion for the woodrat's consumption (Weltfish 1977:321, 415–416). The Yavapai also raided woodrat nests, for piñon nuts. Woodrat brains were preserved for skin dressing, and their skins, with the fur side in, were used as winter foot wrappings for infants (Gifford 1936:257, 266, 275).

14.2.2.6 Procyon lotor (Raccoon)

The raccoon (*Procyon lotor*), which is tentatively represented by a single bone, occurs throughout New Mexico but is most common near permanent water (Davis and Schmidly et al. 1994:232; Findley et al. 1975:298–299; Fitzgerald et al. 1994:327). This medium-sized carnivore is strictly nocturnal and primarily inhabits broadleaf woodlands near water but also occurs in semidesert shrublands. Although large hollow trees or hollow logs are preferred as dens, rock crevices, caves, culverts, brush piles, and abandoned burrows also serve as dens. Breeding generally begins in February and extends through August. After an average gestation period of 63 days, females usually give birth to a single litter of three or four young in April or May. Although females are able to breed in the spring following their birth, most do not breed until their second year. Deciduous teeth are shed in August and September. Raccoons eat both plant and animal matter. Plant foods include wild fruits, grasses, sedges, acorns, pecans and other nuts, and corn. Animal foods include various insects, spiders, earthworms, fish, lizards, snakes, bird eggs, birds, mice, squirrels, and rabbits. In addition to man and his dogs, major predators include great horned owls, coyotes, wolves, gray and red foxes, mountain lions, and bobcats (Davis and Schmidly 1994:232–234; Fitzgerald et al. 1994:327–329; Schwartz and Schwartz 1981:287–288).

The Havasupai (Spier 1928:112) hunted the raccoon for its flesh, as did the Omaha (Fletcher and La Flesche 1911:104). The Pawnee used a raccoon leg band to denote rank and raccoon bone forks had ceremonial significance (Weltfish 1977:155, 376).

14.2.2.7 Odocoileus sp. (Deer)

The archaeofaunal assemblage contains few definite deer specimens (n=8). Historically, two deer species — mule deer (*Odocoileus hemionus*) and white-tailed deer (*O. virginianus*)—occurred in or near the project area (Findley et al. 1975:329, 331). The mule deer, a browser, is found at all elevations and in a variety of habitats—brushy and wooded areas, broken country, and open plains. It inhabits the Upper Sonoran, Transition, and Canadian zones (Bailey 1913:32, 43, 47). As a result, a varied diet is consumed. It is a browser that feeds mainly on oak, juniper, piñon, cliffrose, bitterbrush, fir, ponderosa pine, and aspen. When grazing, forbs are preferred over grasses. Cultivated crops are also consumed. The winter diet primarily consists of juniper, piñon needles, sagebrush, saltbush, and Mormon tea. Formerly, major predators included grizzly bears and wolves. Mountain lions, coyotes, bobcats and eagles also prey on mule deer (Bee et al. 1981:220–221; Cockrum and Petryszyn 1992:164; Davis and Schmidly 1994:278–281; Findley 1987:140–141; Findley et al. 1975:328–329; Hoffmeister 1986:542–543; Zeveloff 1988:326–327).

The white-tailed deer also inhabits the Upper Sonoran, Transition, and Canadian zones (Bailey 1913:32, 1931:35, 37). In areas where both species live close together, white-tailed deer usually occur at higher elevations and in more rugged terrain, "such as steep, rocky, canyon sides" (Findley et al. 1975:330). During summer, white-tailed deer may be found as high as 10,000 ft (Findley et al. 1975:332). This species is "found primarily in woodland communities consisting of evergreen oaks or in mixtures of oak-juniper-pinyon" (Hoffmeister 1986:545). White-tailed deer also occur in desertscrub. Juniper, piñon, hackberry, mesquite, and other bushes and shrubs supply much of their diet. They also eat crops such as corn. Predators of adult white-tailed deer and/or fawns include coyotes, wolves, bobcats, mountain lions, gray foxes, and raptors (Hoffmeister 1986:545, 547–548; Zeveloff 1988:329–330).

Usually, only male deer have antlers, which are shed in early February, at the end of the breeding season. New antlers begin growing in May and remain in velvet until sometime in September when they stop growing. Breeding takes place from late fall to early winter, primarily from December 1 through January 15. Does usually mate for the first time when they are about 18 months old. Deer are K-selected mammals. As a result, the gestation period is almost seven months. In New Mexico, does usually give birth to one or two fawns in June or July (Findley 1987:139–140; Hoffmeister 1986:542, 547).

In pre-Columbian and historical times, deer were important food resources and also provided raw materials for clothing and tools. Deer were one of the principal animals hunted by the Jicarilla Apache. "Whistles, designed to imitate the bleat of the fawn, were used to draw does to their death, and head nooses were strung along trails" (Opler 1936:207). Individuals and small parties of Omaha hunted deer, usually in winter when the deer were fat and in good condition (Fletcher and La Flesche 1911:270–271). The Chippewa had several deer hunting techniques, such as using pitch torches and deer calls; the deer were attracted to the light and a sound similar to that of a fawn (Densmore 1929:128–129, 149). Individual Sanpoil hunters had a similar technique, using a leaf to imitate fawn sounds. Deer hunting by the Sanpoil was mainly a group venture that often occurred during winter and consisted of driving deer to the head of a canyon or valley or into a river where the animals were easily killed. They also drove deer over the edge of a cliff (Ray 1932:77–81). Prior to the acquisition of the horse, the Hopi, working in pairs, sometimes ran down individual deer on foot. More often, however, a group of hunters surrounded and rounded up a number of deer. Although the hunters sometimes killed the exhausted animals with arrows, they usually strangled them (Beaglehole 1936:3–7). Navajo hunters drove deer into an ambush, tracked them down, waited in ambush for the animals to pass by, stalked deer, used animal disguises, occasionally encircled deer with fire, used pit falls, and ran them down on foot (Hill 1938:96–133; Elmore 1953). Some Basin-Plateau groups killed deer with poisoned arrows (Steward 1938:36).

The importance of deer as a raw material source for clothing, tools, and other items is well known and needs no discussion. Several cultural customs associated with deer, however, are presented. The Jicarilla Apache gathered the waste and bones of deer and disposed of them far from camp to ensure continued success in hunting (Opler 1936:207). When the Navajo obtained sufficient deer meat, they broke the accumulated bones. "Not a single one was left whole, because it was believed that by breaking the bones deer hunted in the future would be unable to escape. These bones and the horns were deposited at the base of a cliff rose" (Hill 1938:128). The Hopi did not break the bones for marrow or give them to their dogs but rather, placed the bones (including the skulls) and unused antlers on a shrine (Beaglehole 1936:7–8). The Laguna cooked the head and bones in a large cooking jar (Goldfrank 1954:419), and the Kiliwa ground deer bones to a fine paste in a mortar (Michelsen 1967:77).

14.2.2.8 Antilocapra americana (Pronghorn)

Pronghorn (*Antilocapra americana*) remains (n=135) are the most commonly identified artiodactyl remains in the archaeofaunal assemblage. Although pronghorn formerly occurred throughout the Southwest, intensive hunting greatly reduced their numbers by the early 1900s. Since that time, however, they have been expanding within their former range. Pronghorn, which were once almost as numerous as bison, inhabit arid and semi-arid grasslands, subsisting on browse such as sagebrush, buckbrush, and rabbitbrush. Prickly pear cacti, forbs, grasses, and cultivated crops are also eaten. Most, or all, of the pronghorn's water requirements are supplied by consumed plants. Horns are present in both sexes and the sheaths are shed and replaced annually. Pronghorn congregate in large herds (e.g., 100 individuals) during the winter but disperse into smaller groups in the spring. Breeding occurs in the fall. Females give birth, usually to twins, in mid-June. The pronghorn uses its great speed—up to 60 miles per hour—to elude predators such as bobcats and coyotes (Findley 1987:144–145; Findley et al. 1975:333–334; Hoffmeister 1986:549, 551–552; Jones et al. 1985:318; Zeveloff 1988:334–336).

The pronghorn was a food resource for many North American pre-Columbian and historic peoples. The Cheyenne dug pits and built enclosures on established trails. Large numbers of pronghorn were enticed, drawn, led, or driven into these traps and killed with clubs (Grinnell 1923:I:277–290). Solitary Chiricahua Apache hunters stalked pronghorn (Opler 1941:324). Pronghorn was the Navajo's second most important meat source. Many deer hunting techniques also served to bring down pronghorn. Animals were stalked, tracked, flushed, driven into an ambush, run down, or driven into a corral by a pair or group of Navajo hunters, but impounding was the most common method (Hill 1938:101–113, 117–131, 145–156). The Hopi also used deer hunting methods to procure pronghorn and treated the bones in a similar manner (Beaglehole 1936:4–9). The Pima stalked pronghorn (Ebeling 1986:594). During the summer and fall, the Sanpoil, hunting singly or in pairs with bows and arrows, often found pronghorn near water holes (Ray 1932:82). The Shoshone and Crow conducted communal pronghorn drives into corrals (Lowie 1922:211; Steward 1938:34–35, 81–82). The Havasupai occasionally wore a disguise when stalking pronghorn. "The stuffed headskin of an antelope is worn on the head, while the body is painted pink and white to resemble that animal. Mimicking its actions, the hunter approaches within 10 or 15 m before he lets fly" (Spier 1928:110). The Yavapai hunted pronghorn by stalking, driving, or surrounding them. In addition to eating the meat of this animal, its marrow was also consumed (Gifford 1932:216, 1936:265).

Pronghorn also provided raw material for various items, of which only a few are presented. The Yavapai used pronghorn skins for leggings, breechcloths and drumheads, but because pronghorn skin is thin and easily torn, they did not use it for all the same purposes as deer hides (Gifford 1936:273–274, 288). The Yavapai also used pronghorn horns as flakers (Gifford 1936:287). The Havasupai made ropes from pronghorn skin (Spier 1928:146), and the Hopi used the pronghorn horn as an arrow wrench (Spier 1928:161). The Navajo made clothes from pronghorn hides, but the hides were not sturdy enough for moccasins (Hill 1938:156).

14.2.2.9 Bison bison (Bison)

The Laguna Plata faunal assemblage contains bison (*Bison bison*) (n=11) and bison-size (n=44) remains. Most, if not all, of the latter are probably bison. The bison, the largest extant terrestrial mammal in North America, was formerly the dominant mammal of the prairies. This grazer of open grasslands once numbered in the millions, but has been extirpated throughout most of its range. By 1890, fewer than 1,000 bison were left in North America. In 1884, the last recorded killing of free-ranging bison in New Mexico occurred (Findley 1987:146). "Extermination of the bison was part of a United States government policy to suppress the Indian tribes that depended on them for food, clothing, and shelter. At the turn of the century, efforts were finally made to save them [bison] from extinction" (Zeveloff 1988:345). Today, almost 100,000 bison survive in public and private herds in western North America.

Although the bison is primarily a grassland species, it also inhabits forest edges and the prairie-forest transition zone. This bovid is very gregarious, living in large herds. Core herds consist of females, calves, yearlings, and two-year-olds. Older males are solitary or form small groups on the peripheries of the main herds. During the breeding season, from mid- to late summer, the males join the female-subadult herds. The bison is a K-selected species. After a gestation period of 9.5 months, a single precocial calf per breeding female is usually born in the spring. Occasionally, a female may have twins. Although sexual maturity is attained by the age of three for both sexes, males generally do not breed much until the age of six (Bee et al. 1981:229–230; Findley 1987:146; Zeveloff 1988:346–347).

Bison are efficient grazers. They are "capable of growing and maintaining good condition on less nutritious fare than domestic cattle require" (Findley 1987:146). Although grasses are preferred, sedges and brushy plants are consumed when grass is unavailable. Bison seek water each day. During droughts, however, they can go several days without water. Besides humans, major predators include wolves and grizzly bears (Bailey 1931:16; Bee et al. 1981:230; Findley 1987:146; Zeveloff 1988:346). The importance of bison as a food resource and as a raw material source for clothing, tools, and other items among various Plains peoples is well known and is not discussed herein.

14.3 The Laguna Plata (LA 5148) Archaeofaunal Assemblage

The Laguna Plata (LA 5148) archaeofaunal assemblage actually consists of three separate assemblages (see Table14.1) excavated at different times (i.e., 1970 and 2010) and under differing scopes of work—the 1970 LCAS excavations and the 2010 testing and off-site trenching project. Therefore, because the assemblages are not comparable, each is examined separately.

14.3.1 The 1970 LCAS Assemblage

The archaeofaunal assemblage recovered by LCAS consists of 1810 specimens. Excavation damage is common and except for carpals, tarsals, and most metacarpals, metatarsals, and phalanges, the various elements are broken. In addition, the eroded or corroded condition of the bones has resulted in further fragmentation. Corrosion is indicative of burial in highly acidic soils, of root etching, and/or the presence of organic acids (e.g., urine) (Andrews 1990:19) and has obscured evidence of gnawing, butchering, and use. As a result, gnawing was only identified on 108 specimens (6.0 percent), of which 100 (92.6 percent) are rodent gnawed, seven exhibit carnivore gnawing, and one was gnawed by both. This incidence is low, given the presence of pocket gophers and woodrat. In addition, butchering marks were only observed on 18 specimens (1.0 percent) and three worked bones were identified, including two awls.

The assemblage is primarily from three features and a large dense midden (Table 14.2). Separate MNIs were calculated for the identified taxa in each provenience and are presented in parentheses in Table 14.2. Few faunal remains (n=26, 1.4 percent) were found outside these proveniences ("Other" in Table 14.2). As indicated in Table 14.2, most of the assemblage (n=1107, 61.2 percent) is from Feature 1, a pithouse that had been heavily vandalized prior to excavation (LCAS 1971:7), and its associated contiguous units. Features 2 and 3, also pithouses, include their associated contiguous units. The midden assemblage is from the seven noncontiguous units in the northern portion of the large midden, north of the pithouses. The faunal remains of the "Other" category are from scattered units. Each sub-assemblage is discussed separately.

14.3.1.1 Feature 1

As stated above, most of the LCAS archaeofaunal assemblage is from Feature 1 (n=1107, 61.2 percent), which contains a variety of taxa (Table 14.2). Half of the assemblage, however, consists of the remains of various indeterminate size mammals (n=557, 50.3 percent). All of the identified taxa (family or lower) are potentially cultural. The box turtle specimens (n=10) consist of six carapace and three plastron fragments and an indeterminate shell fragment. The carapace specimens include a nuchal fragment and a complete pygal. No cranial or limb elements are present. Although its presence is considered cultural, it is unclear as to whether the box turtle was procured as a food resource and/or for its shell. The prairie dog remains (n=15) consist of a maxilla fragment, three mandibles, teeth (n=9), a frontal fragment, and a nearly complete tibia that exhibits a healed fracture on the proximal end. Both ends of the fracture are offset and have fused at an unnatural angle. The specimens are low meat value elements that may represent butchering debris. The pocket gopher specimens (n=5) consist of an upper incisor and a mandible with three teeth, and the woodrat specimen (n=1) is a nearly complete occipital. Although all are low meat value elements suggestive of butchering debris, the specimens may be intrusive. The probable raccoon bone (n=1) is the distal shaft of a humerus. None of the turtle, raccoon, or rodent remains is burned or exhibits gnawing or butchering marks.

The remaining identified taxa—various leporids (cottontails and jackrabbits) and artiodactyls (e.g., deer, pronghorn, bison)—are definitely subsistence-related animals. Most of the identified remains (n=550) are those of leporids (n=342, 62.2 percent). The Leporidae category consists of those leporid specimens that could not be identified confidently as either cottontail or jackrabbit. All of the major portions of the leporid skeleton—skull, trunk, foreleg, hindleg, and feet—are represented (Table 14.3, Figures 14.1 and 14.2). Both low and high meat value bones, indicative of butchering debris and food refuse, are present. The incidence of burning (n=14, 4.1 percent) and gnawing (n=19, 5.6 percent) is low, with 12 charred, two calcined, and 19 rodent gnawed (Table 14.4). Transverse cuts indicative of dismembering are on the anterior surface of the distal end of a cottontail humerus (Table 14.5). No other leporid remains exhibit butchering marks.

Table 14.2 Faunal assemblage from LCAS excavations

Taxon	Feat. 1	Feat. 2	Feat. 3	Midden	Other	Total
Terrapene ornata (Western Box Turtle)	10 (1)	10 (1)	1 (1)	1 (1)		**22 (4)**
Colubridae (Colubrid Snakes)		1 (1)				**1 (1)**
Indeterminate large bird (Turkey-size)			1 (1)			**1 (1)**
Leporidae (Rabbits, Hares)	28	1	5 (1)	2	1	**37 (1)**
Sylvilagus audubonii (Desert Cottontail)	92 (7)	35 (3)	33 (3)	5 (1)	1 (1)	**166 (15)**
Lepus californicus (Black-tailed Jackrabbit)	222 (10)	53 (2)	91 (5)	13 (2)	11 (2)	**390 (21)**
Cynomys ludovicianus (Black-tailed Prairie Dog)	15 (2)	1 (1)	1 (1)			**17 (4)**
Cratogeomys castanops (Yellow-faced Pocket Gopher)	5 (1)	1 (1)	2 (1)			**8 (3)**
Neotoma sp. (Woodrat)	1 (1)					**1 (1)**
cf. *Procyon lotor* (?Raccoon)	1 (1)					**1 (1)**
Odocoileus sp. (Deer)	2 (1)	1 (1)	4 (1)	1 (1)		**8 (4)**
Antilocapra americana (Pronghorn)	106 (6)		23 (1)			**129 (7)**
cf. *Antilocapra americana* (?Pronghorn)	6					**6**
Odocoileus/Antilocapra americana (Deer/Pronghorn)	56	3	4	2	1	**66**
Bison bison (Bison)	3 (1)					**3 (1)**
cf. *Bison bison* (?Bison)	3 (1)		5 (1)			**8 (2)**
Indeterminate small mammal (rabbit-size)	126	44	69	14	7	**260**
Indeterminate medium mammal (coyote-size)	7	7	3	1		**18**
Indeterminate large mammal (pronghorn-size)	392	98	68	61	5	**624**
Indeterminate very large mammal (bison-size)	32	3	8	1		**44**
Total	**1107 (32)**	**258 (10)**	**318 (16)**	**101 (5)**	**26 (3)**	**1810 (66)**

(no.) = MNI

Table 14.3 Leporid skeletal elements from Feature 1, LCAS excavations

Element	Leporidae	Cottontail	Jackrabbit	Total
Skull:				
Frontal			2	**2**
Premaxilla			2	**2**
Maxilla/Mandible	13			**13**
Maxilla		3	3	**6**
Mandible		9	15	**24**
Jugal			2	**2**
Cranial Fragment	1			**1**
Teeth	10	17	32	**59**
Trunk:				
Lumbar Vertebra	2	1	6	**9**
Rib			3	**3**
Foreleg:				
Scapula		3	8	**11**
Humerus		12	16	**28**
Radius			20	**20**
Ulna		1	5	**6**
Hindleg:				
Innominate		13	17	**30**
Femur		18	24	**42**
Tibia		10	36	**46**
Feet:				
Metacarpals			3	**3**
Calcaneum		3	9	**12**
Metatarsals		2	15	**17**
Metapodial Fragment	1		3	**4**
1st Phalanx	1		1	**2**
Total	**28**	**92**	**222**	**342**

Table 14.4 Burned and gnawed taxa from Feature 1, LCAS excavations

Taxon	NISP	Burned		Gnawed		
		CH	CAL	R	C	R&C
Sylvilagus audubonii (Desert Cottontail)	92	2		4		
Lepus californicus (Black-tailed Jackrabbit)	222	10	2	15		
Antilocapra americana (Pronghorn)	106			15	1	
cf. *Antilocapra americana* (?Pronghorn)	6		1			
Odocoileus/Antilocapra americana (Deer/Pronghorn)	56	3		7		1
cf. *Bison bison* (?Bison)	3			1		
Indeterminate small mammal (rabbit-size)	126	3		3		
Indeterminate medium mammal (coyote-size)	7	4				
Indeterminate large mammal (pronghorn-size)	392	39	5	15	3	
Indeterminate very large mammal (bison-size)	32	2		1	3	
Total	**1042**	**63**	**8**	**61**	**7**	**1**

CH = charred, CAL = calcined; R = rodent, C = carnivore, R&C = rodent and carnivore

Table 14.5 Butchered taxa from Feature 1, LCAS excavations

Taxon	NISP	Butchering Type			
		S	DM	DF	Total
Sylvilagus audubonii (Desert Cottontail)	92		1		1
Antilocapra americana (Pronghorn)	106	1	7	2	10
Odocoileus/Antilocapra americana (Deer/Pronghorn)	56		2	1	3
Bison bison (Bison)	3		1	1	2
Indeterminate large mammal (pronghorn-size)	392		1	1	2
Indeterminate very large mammal (bison-size)	32			2	2
Total	**681**	**1**	**12**	**7**	**20**

S = skinning, DM = dismembering, DF = defleshing

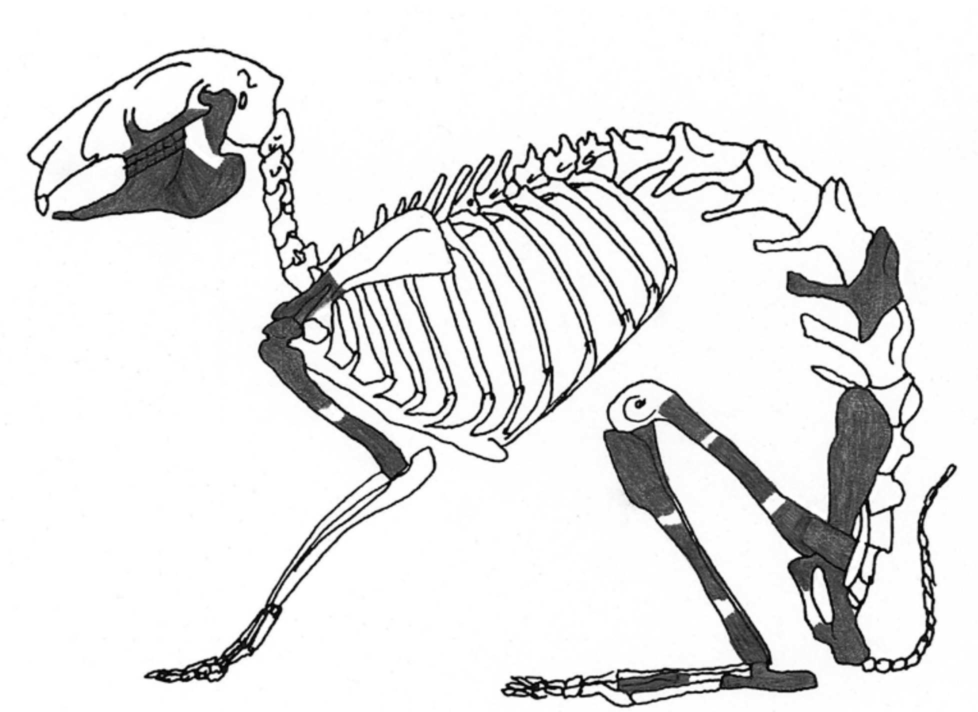

Figure 14.1 Cottontail skeletal part representation, Feature 1, LCAS excavations

The second most numerous identified remains are those of artiodactyls (n=176, 32.0 percent). Although all of the major portions of the skeleton are represented (Table 14.6), the only deer specimens (n=2) are an antler and innominate fragment. The former is a low meat value element and the latter is a high meat value bone. Most of the artiodactyl specimens are those of pronghorn (n=112, 63.6 percent), and most of the pronghorn skeleton is represented (Table 14.6, Figure 14.3). Deer and pronghorn are very similar osteologically. The deer/pronghorn category, therefore, consists of those specimens that could not be identified confidently as either one. Interestingly, except for a pronghorn atlas vertebra fragment, all of the trunk specimens are identified as deer/pronghorn (Figures 14.3 and14.4). These are elements that are generally more difficult or impossible to identify specifically as either deer or pronghorn. Considering that Feature 1 contains the remains of at least six pronghorn, as opposed to one deer (Table 14.2), the deer/pronghorn remains (n=56) are primarily, if not entirely, those of pronghorn. The pronghorn and deer/pronghorn remains are indicative of butchering debris and food refuse. The presence of the pronghorn occipital and basioccipital (Table 14.6) is probably associated with removal of the brain, possibly to dress leather. Bison (n=6) is represented by humerus, femur, and tibia shaft fragments (Table 14.6, Figure 14.5). These elements are high meat value bones indicative of food refuse and marrow extraction. The incidence of burning among the artiodactyl remains is very low (n=4, 2.3 percent), with three charred and one calcined (Table 14.4). The incidence of gnawing is considerably greater (n=25, 14.2 percent), with 23 rodent gnawed, one carnivore gnawed, and one gnawed by both (Table 14.4).

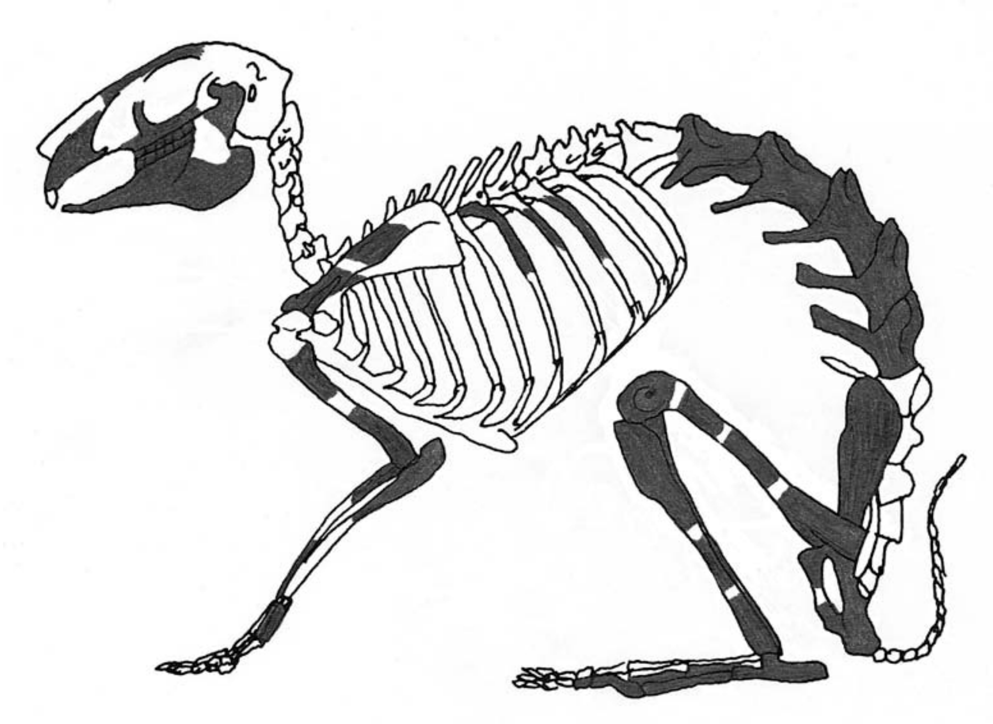

Figure 14.2 Jackrabbit skeletal part representation, Feature 1, LCAS excavations

Table 14.6 Artiodactyl skeletal elements from Feature 1, LCAS excavations

Element	Deer	Pronghorn	Deer/ Pronghorn	Bison	Total
Skull:					
Antler/Horn Core	1				**1**
Nasal		1			**1**
Squamosal		1			**1**
Occipital		1			**1**
Basioccipital		1			**1**
Maxilla		1			**1**
Mandible		2	1		**3**
Maxilla/Mandible		1	3		**4**
Hyoid			1		**1**
Teeth - Complete		4			**4**
Teeth - Fragments		23	1		**24**

Element	Deer	Pronghorn	Deer/ Pronghorn	Bison	Total
Trunk:					
Atlas Vertebra		1			**1**
Cervical Vertebra			1		**1**
Thoracic Vertebra			3		**3**
Lumbar Vertebra			3		**3**
Vertebra Fragment			1		**1**
Sternebra			3		**3**
Rib			9		**9**
Ossified Costal Cartilage			1		**1**
Foreleg:					
Scapula		5	2		**7**
Humerus		9	1	1	**11**
Radius		7	4		**11**
Ulna		6			**6**
Hindleg:					
Innominate	1	12	3		**16**
Femur		8	12	2	**22**
Patella		3			**3**
Tibia		8	4	3	**15**
Feet:					
Metacarpals		1			**1**
Calcaneum		2			**2**
Astragalus		1			**1**
Naviculo-cuboid		1			**1**
Other Tarsals		2			**2**
Metatarsals		4	1		**5**
Metapodial Fragment			2		**2**
1st Phalanx		3			**3**
2nd Phalanx		2			**2**
3rd Phalanx		2			**2**
Total	**2**	**112**	**56**	**6**	**176**

Butchering marks are present on 15 artiodactyl specimens—10 pronghorn, three deer/pronghorn, and two bison (Table 14.5). Among the pronghorn specimens, transverse cut marks indicative of skinning are on a first phalanx. Dismembering cut marks (n=6) are on three humeri, a radius, an innominate, and a femur, and dismembering chop marks (n=1) are on an innominate. Two innominate fragments exhibit defleshing cut marks. In addition, a nearly complete scapula has a 5-mm diameter hole in the blade portion. The hole originated from the lateral side and is suggestive of a wound caused by a small arrow point. The deer/pronghorn butchering marks (n=3) consist of dismembering cut marks on a cervical vertebra fragment and on a distal metatarsal shaft fragment and defleshing cut marks on a rib. Bison butchering marks consist of transverse dismembering cut marks on a distal fragment of a tibia and a transverse defleshing cut mark on a distal shaft fragment of a humerus.

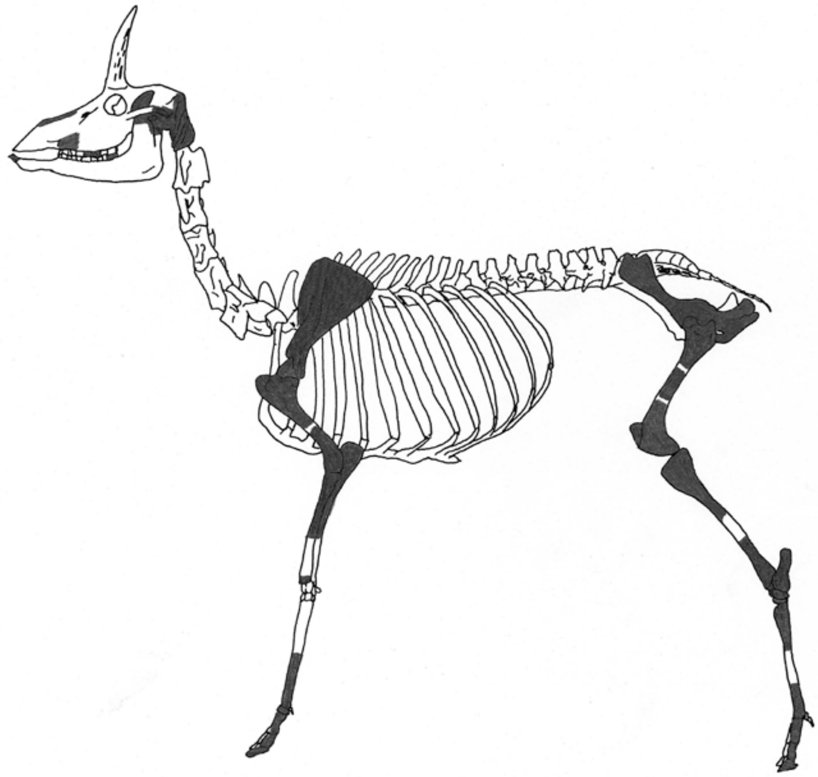

Figure 14.3 Pronghorn skeletal part representation, Feature 1, LCAS excavations

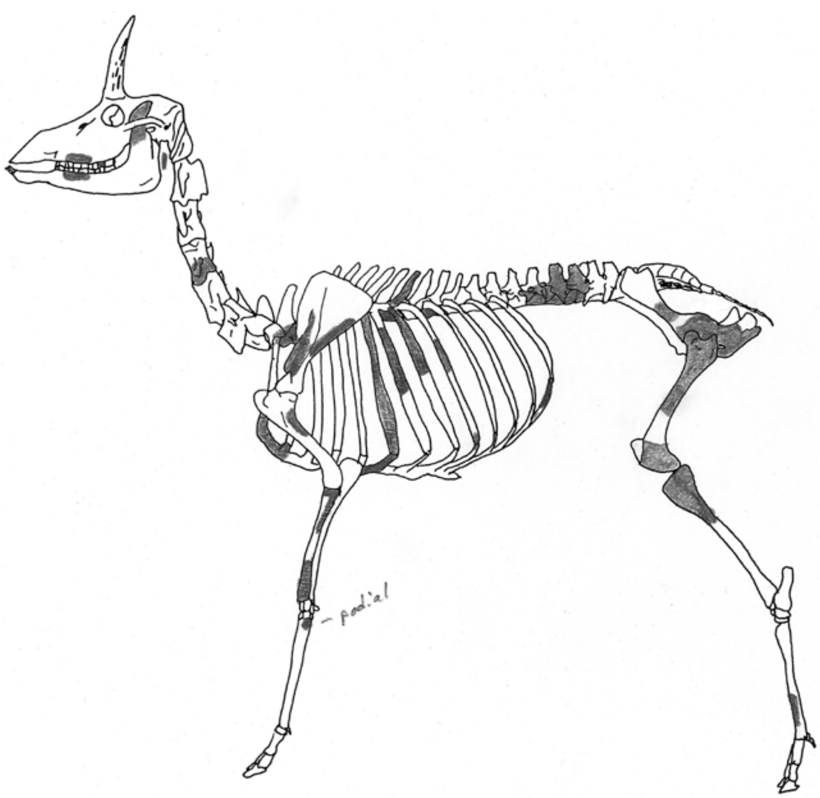

Figure 14.4 Deer/pronghorn skeletal part representation, Feature 1, LCAS excavations

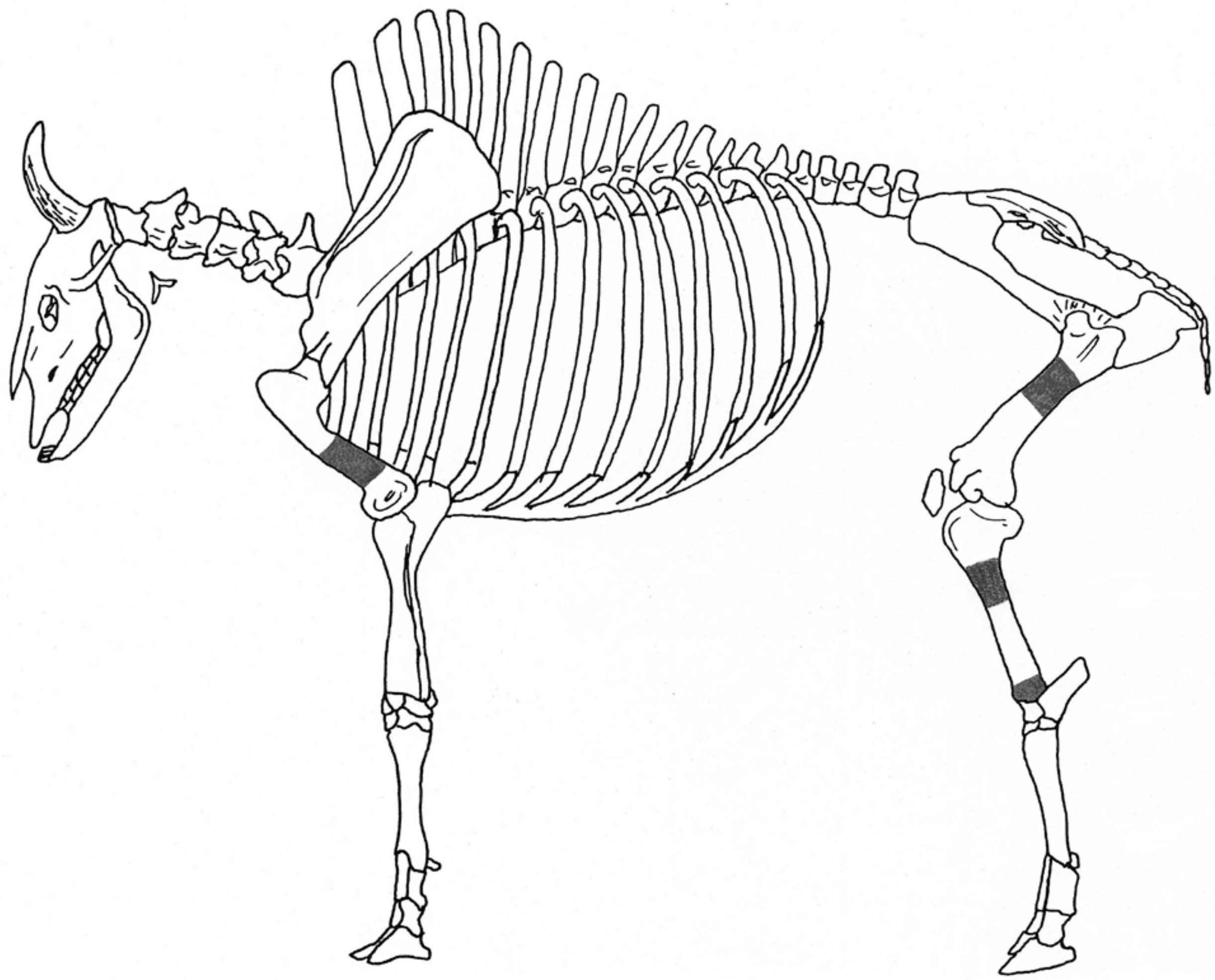

Figure 14.5 Bison skeletal part representation, Feature 1, LCAS excavations

In addition to butchering marks, five butchering units—represented by two or more bones that articulate—are present. Four butchering units are pronghorn and consist of 1) the first through third phalanges; 2) the first and second phalanges; 3) a distal tibia, calcaneum, and astragalus; and 4) a naviculo-cuboid, fused second and third tarsal, and proximal metatarsal. All represent primary butchering debris, removal of the feet. The presence of these units indicates whole pronghorn were brought to the site and were probably procured nearby. The fifth butchering unit consists of two complete deer/pronghorn lumbar vertebrae and represents processing or consumption refuse.

The artiodactyl remains also include one worked bone, a complete awl made from the distal end and shaft of a pronghorn metacarpal (Figure 14.6). The specimen is eroded and covered with calcium carbonate. A drying crack is along the working end. The awl is 10.9 cm long, weighs 14.72 g, and has a round, blunt tip.

Figure 14.6 Awl, Feature 1, LCAS excavations

The indeterminate mammal portion of the assemblage accounts for half of the Feature 1 faunal remains (n=557, 50.3 percent) (Table 14.2). Given the paucity of rodent remains and the absence of mouse-size remains, most, if not all, of the rabbit-size specimens (n=126) are probably leporid. The incidence of burning (n=3, 2.4 percent) and gnawing (n=3, 2.4 percent) is low (Table 14.4), with three charred and three rodent gnawed. The assemblage includes few coyote-size remains (n=7), of which four (57.1 percent) are charred (Table 14.4). None, however, is gnawed. Most of the indeterminate assemblage consists of pronghorn-size remains (n=392, 70.4 percent) and probably represents primarily pronghorn. Most of the Feature 1 burned remains are pronghorn-size (n=44, 62.0 percent). Five are calcined and 39 are charred. In addition, 18 pronghorn-size remains are gnawed, 15 by rodents and 3 by carnivores (Table 14.4). Two bison-size specimens are charred and four are gnawed, one by rodents and three by carnivores (Table 14.4). No butchering marks are present on the rabbit- and coyote-size remains, One pronghorn-size specimen has dismembering cut marks and another specimen and two bison-size remains have defleshing cut marks (Table 14.5).

14.3.1.1.1 *Discussion*

No radiocarbon dates are available for Feature 1, but diagnostic artifacts—ceramics and projectile points—indicate it dates to the Formative period. Although most of the vertebrate faunal remains recovered from the LCAS excavations were from Feature 1, the assemblage is very biased. First, the cultural deposits were disturbed by looters prior to LCAS's fieldwork (LCAS 1971:7). As a result, an unknown portion of the cultural deposits was removed and probably redeposited elsewhere on the site. In addition, rodents are underrepresented. The recovery of 61 rodent-gnawed specimens attests to the presence of rodents. Although the LCAS used screens (LCAS 1971:5), the report does not indicate if all faunal remains were collected. It is possible that only those bones thought to be cultural (i.e., non-rodents) were collected. In addition, although not explicitly stated, the screens probably consisted of ¼-inch hardware cloth. Consequently, small bones, such as leporid phalanges, carpals, and tarsals, and the bones of small rodents undoubtedly fell through the screens.

Sifting experiments by Shaffer (1992) and Shaffer and Sanchez (1994) indicate that for mammals weighing less than 140 g, such as the kangaroo rat, almost all of the skeletal elements, except for the cranium and innominates, are lost with ¼-inch sifting. "Most elements from animals weighing 71–340 g [such as the woodrat and pocket gopher] also will be missed with ¼[-inch] screening. However, these taxa are often large enough for several commonly identifiable elements to be recovered (pelves, femora, humeri, skulls, and mandibles)" (Shaffer 1992:131). For mammals weighing between 340 and 3,100 g, such as the cottontail and jackrabbit, skeletal elements are well represented with ¼-inch sifting. However, "even though many identifiable elements are recovered, other elements such as caudal vertebrae, ribs, sternae, patellae, sesamoids, podials, metapodials, and phalanges were not recovered consistently" (Shaffer 1992:131). For mammals weighing more than 4,500 g, such as the coyote, most elements were recovered, except for sesamoids, carpals, patellae, and the second and third phalanges (Shaffer 1992:134). The use of ¼-inch screens, therefore, may partially explain the presence of only, or primarily, cranial elements (including maxillae and mandibles with and without teeth) for the prairie dog, pocket gopher, and woodrat. The prairie dog remains also include the tibia with the healed fracture. Although these rodents were consumed as secondary food resources by various groups (see Natural History and Ethnographic Background), the data from Feature 1 are inconclusive concerning their use as meat supplements by the inhabitants of LA 5148.

Although the major portions of the leporid skeleton are represented, the jackrabbit exhibits greater skeletal representation within those portions than cottontail (Table 14.3 Figures 14.1 and 14.2). As indicated in Table 14.3 (Figure 14.1), a number of cottontail elements are missing. The skull is only represented by the maxilla, mandible, and teeth and the only trunk element is a lumbar vertebra. Except for an ulna, the lower foreleg is missing, and the only foot elements are the calcaneum and metatarsals. Skull and foot bones are low food-value elements that were probably discarded as butchering debris. The near absence of trunk bones (vertebrae and ribs) suggests vertebrae and ribs were processed differently than the rest of the carcass. As indicated ethnographically (see Natural History and Ethnographic Background), these bones may have been pulverized and consumed with the meat. Tyler (1975:133) reports the grinding of rabbit bones by the Zuni. The smashing of small mammal vertebrae was documented by Steward (1941:232, 1943:304, 364) for the Shoshoni. In addition, based on the authors' experience with Cornish hens, baking or boiling small animals can soften bones such as cervical and thoracic vertebrae and ribs, allowing incidental consumption with the meat. Similar methods of carcass preparation could account for the skeletal part representation reflected by the cottontail remains. The exhibited pattern, however, may have resulted from the use of ¼-inch screens. The missing elements are those mentioned by Shaffer (1992:131) for mammals weighing between 340 and 3,100 g.

The average length of a desert cottontail is 385.4 mm. On average, a male weighs 841.0 g and a female weighs 988.5 g (Chapman and Willner 1978:1). The length of the black-tailed jackrabbit ranges from 523–606 mm and on average, a male weighs 2475 g and a female weighs 2610 g (Best 1996:2). The better representation of the jackrabbit skeleton in the Feature 1 assemblage, therefore, may be due to its larger size. Elements of the entire leporid skeleton—both low and high meat value elements—are present in the assemblage (Table 14.3 Figures 14.1 and 14.2), indicating the processing and consumption of rabbits occurred near Feature 1. As with the cottontail, however, jackrabbit vertebrae and ribs—two of the most abundant elements in a mammalian skeleton—are underrepresented. The paucity or absence of these elements is not the result of preservation factors. Other thin-walled bones—cranial elements, scapulae, and innominates—were recovered. As suggested for the cottontail, the vertebra-rib pattern may be attributable to recovery techniques (e.g., use of ¼-inch screens) or carcass processing. If the former was the limiting factor, the long transverse spines of lumbar vertebrae may have enhanced recovery of these elements.

The leporid long bones are generally broken but much of the breakage seems to be post-depositional. In addition, most of the rabbit-size remains are long bone shaft fragments (n=95, 75.4 percent). It is doubtful that the rabbit and rabbit-size long bone specimens were processed formally for marrow or grease. Long bones may have been broken during butchering, consumption, or discard. Long bone fragmentation may also have resulted from trampling by humans and animals (Andrews 1990:8–10; Binford 1981:78; Haynes 1991:141–142,253; Lyman 1994:379, 381). Documentation of changes in bones and ethnoarchaeological and experimental contexts has indicated that the fossil record can be greatly modified from its depositional condition by trampling. Bones may be moved, broken, and scratched by trampling (Lyman 1994:381). Trampling experiments by Andrews (1990:8–10) on owl pellets (single pellets in plastic bags) containing small mammal bones resulted in the destruction of skulls, the fragmentation of mandibles, and an abundance of isolated teeth. Scapulae and innominates were partially fragmented. Although long bones, vertebrae, ribs, and foot bones tended to remain intact after six trampling episodes, examination of an assemblage of small mammal bones from a trampled (by owls and other small animals) context in a small cave indicated the absence of skulls, reduced numbers of maxillae, considerable fragmentation of most major postcranial elements, with some loss, "but no loss or breakage of smaller elements" (Andrews 1990:10). Discounting teeth, Table 14.3 indicates the paucity or absence of leporid cranial elements, similar to Andrews' results. In addition, Table 14.7 shows the fragmentation of the major long bones. Except for the ulna, the bones are primarily represented by shaft fragments. Although not necessarily conclusive, the leporid skeletal part representation and long bone breakage data and the site's proximity to Laguna Plata, a water source, suggest at least some of the patterns exhibited by the remains are the result of trampling by humans and animals living on the site and/or crossing the site to and from water.

Table 14.7 Breakage pattern of major leporid long bones, Feature 1, LCAS excavations

Element/ Portion	Cottontail	Jackrabbit	Total
Humerus:			
Proximal	2		**2**
Shaft	6	8	**14**
Distal	4	8	**12**
Radius:			
Proximal		6	**6**
Shaft		9	**9**
Distal		5	**5**
Ulna:			
Proximal	1	5	**6**
Femur:			
Proximal	4	1	**5**
Shaft	14	21	**35**
Distal		2	**2**
Tibia:			
Proximal	2	1	**3**
Shaft	6	28	**35**
Distal	1	7	**8**

Based on the fusion, or lack thereof, of epiphyseal ends, at least one very immature (probably fetal/neonatal) indeterminate leporid; two immature, one nearly mature, and two mature cottontails; and two immature and four mature jackrabbits are represented. The incidence of burning among the leporid and rabbit-size remains is very low (n=17, 3.6 percent) (Table 14.4). Only two specimens are calcined. Although natural fires can carbonize bones, they rarely calcine bones (David 1990:75). As stated by Lyman (1994:388–389), calcination requires "longer heating times, higher temperatures, or both, relative to carbonization." Calcination requires "temperatures of over 450–500°C, or heating for over three to four hours, or a combination of both" (David 1990:69). Natural conditions rarely calcine bones but can blacken them (David 1990:75). The calcined bones represent intentional discard into fire. The charred (partially or completely blackened) specimens may be associated with food preparation, such as roasting over a fire, or with discard into a fire with a reducing atmosphere.

As indicated by Table 14.6 (Figures 14.3 and 14.4), essentially the entire artiodactyl skeleton is represented by the pronghorn and deer/pronghorn (probably primarily pronghorn) remains. This suggests pronghorn were procured near the site. This is also indicated by the presence of four identified pronghorn butchering units consisting of lower leg and foot elements. The paucity of definite deer remains (n=2), which consists of a low meat value element (antler) and a high meat value element (innominate), may have resulted from longer-distance hunting. The antler may have been brought to the site as raw material for tools, such as antler flakers. The meat probably was still attached to the innominate when brought to the site. Except for tarsals, phalanges, two nearly complete innominates, and a nearly complete scapula, the pronghorn and deer/pronghorn elements are fragmented, probably for the extraction of marrow and grease. The largest category of faunal remains in the Feature 1 consists of pronghorn-size remains (n=392, 35.4 percent), most of which are indeterminate fragments (n=328, 83.7 percent) but also includes long bone shaft fragments (n=40, 10.2 percent), two vertebra fragments, and 22 rib shaft fragments. Some of the breakage, however, may be due to trampling. The incidence of burning among the artiodactyl and pronghorn-size remains is low (n=48, 8.5 percent) but accounts for most (67.6 percent) of the burning exhibited by the Feature 1 assemblage (Table 14.4). Overall, the non-bison artiodactyl remains represent complete carcasses that were brought to the site for processing (i.e., butchering and cooking) and consumption, with further processing for marrow and for tools, such as awls.

The presence of Laguna Plata, with its springs and seeps, suggests bison were undoubtedly attracted to the area. The paucity of bison (n=6) and bison-size (n=32) remains at LA 5148 itself, therefore, indicates bison were not necessarily killed at the site, but in the general vicinity. The presence of foreleg and hindleg elements suggests that distance was not unduly far (Table 14.6, Figure 14.5). The bison remains consist of humerus, femur, and tibia shaft fragments and a distal tibia fragment. These bones are high meat value elements that also have high marrow content. The bison-size specimens (n=32) include ossified costal cartilage (n=1), rib (n=5), long bone shaft (n=7), and indeterminate (n=19) fragments. The broken condition of the bones suggests processing for marrow, which was probably one of the main reasons why these limb bones were brought to the site. Evidence of bone grease production, however, is lacking. No large piles of pulverized bone or fire-cracked rock (cf. Binford 1978:159; Quigg 1997; Vehik 1977) were reported (LCAS 1971). As stated by Vehik (1977:172), “the primary archaeological evidence for bone grease manufacturing can only be the presence of many small pieces of unburned animal bone.” The site occupants, therefore, were probably not experiencing food stress and did not need to maximize the food value of their meat resources.

14.3.1.2 Feature 2

The Feature 2 archaeofaunal assemblage (n=258) is the smallest of the three feature assemblages (Table 14.2). Most of the assemblage consists of the remains of various indeterminate size mammals (n=152, 58.9 percent). The colubrid (non-venomous) snake, represented by one vertebra, is considered intrusive. The other identified taxa are cultural or potentially cultural. The box turtle specimens (n=10) consist of four carapace and five plastron fragments and an indeterminate shell fragment. The carapace fragments include a complete nuchal. As with Feature 1, the box turtle is considered cultural but its procurement as a food resource and/or for its shell is unclear. No non-shell turtle elements were recovered. The prairie dog specimen is the distal end and shaft of a humerus and the pocket gopher bone is a nearly complete tibia. The humerus exhibits rodent gnawing. None of the specimens is burned or has butchering marks. As with Feature 1, the paucity of the rodent remains precludes determination of their use as supplemental meat resources.

The balance of the identified taxa consists of leporids and artiodactyls (Table 14.2). The vast majority of the identified remains are those of leporids (n=89, 84.0 percent). The single Leporidae specimen is a complete first phalanx, a low meat value element indicative of butchering debris. The skeletal part representations for cottontail and jackrabbit are very similar (Table 14.8, Figures 14.7 and 14.8). Although the foreleg and hindleg—high meat value portions—are represented by the major leg elements, most skull, trunk, and foot elements—low and medium meat value portions—are missing or poorly represented. The leg specimens and rib represent food refuse and the other specimens are butchering or processing debris. The incidence of burning (n=5, 5.6 percent) and gnawing (n=6, 6.7 percent) is low (Table 14.9). No leporid remains exhibit butchering marks, and none is worked.

The Feature 2 faunal assemblage contains few artiodactyl remains (n=4) (Table 14.2). A complete astragalus, a low meat-value foot element, is the only deer bone (Table 14.10). Deer/pronghorn specimens (n=3) consist of a calcined thoracic vertebra fragment and a metatarsal and indeterminate metapodial fragment. The artiodactyl remains are indicative of butchering debris (foot elements) and food refuse (vertebra). Except for the calcined astragalus, the artiodactyl remains are not burned, gnawed, or worked, and none exhibits butchering marks.

As with the Feature 1 assemblage, due to the paucity of rodent remains, most, if not all, of the rabbit-size specimens (n=44) are probably leporid (Table 14.2). Except a rib shaft and five indeterminate fragments, all (n=38, 86.4 percent) are long bone shaft fragments. The incidence of burning is low (n=6, 13.6 percent), with five charred and one calcined (Table 14.9). None is gnawed or worked or has butchering marks. Most of the pronghorn-size remains consist of indeterminate fragments (n=79, 80.6 percent). The other 19 are long bone shaft fragments. Of the five burned bones, three are charred and two are calcined. Two have rodent gnawing (Table 14.9). The coyote-size specimens (n=7) consist of two long bone shaft fragments and five indeterminate fragments and the bison-size remains (n=3) consist of a long bone shaft fragment and two indeterminate fragments. None is burned, gnawed, or worked or has butchering marks.

Table 14.8 Leporid skeletal elements from Feature 2, LCAS excavations

Element	Leporidae	Cottontail	Jackrabbit	Total
Skull:				
Frontal		1		**1**
Mandible		3	4	**7**
Teeth		9	10	**19**
Trunk:				
Rib			1	**1**
Foreleg:				
Scapula		1	2	**3**
Humerus		2	5	**7**
Radius		1	3	**4**
Ulna			1	**1**
Hindleg:				
Innominate		5	5	**10**
Femur		6	8	**14**
Tibia		6	8	**14**
Feet:				
Calcaneum		1	2	**3**
Metatarsals			4	**4**
1st Phalanx	1			**1**
Total	**1**	**35**	**53**	**89**

Table 14.9 Burned and gawed taxa from Feature 2, LCAS excavations

Taxon	NISP	Burned		Gnawed
		CH	CAL	R
Sylvilagus audubonii (Desert Cottontail)	35	1		4
Lepus californicus (Black-tailed Jackrabbit)	53	3	1	2
Cynomys ludovicianus (Black-tailed Prairie Dog)	1			1
Odocoileus/Antilocapra americana (Deer/Pronghorn)	3		1	
Indeterminate small mammal (rabbit-size)	44	5	1	
Indeterminate large mammal (pronghorn-size)	98	3	2	2
Total	**234**	**12**	**5**	**9**

CH = charred, CAL = calcined; R = rodent

Table 14.10 Artiodactyl skeletal elements from Feature 2, LCAS excavations

Element	Deer	Deer/ Pronghorn	Total
Trunk:			
Thoracic Vertebra		1	**1**
Feet:			
Astragalus	1		**1**
Metatarsals		1	**1**
Metapodial Fragment		1	**1**
Total	**1**	**3**	**4**

14.3.1.2.1 *Discussion*

Like Feature 1, the Feature 2 faunal assemblage is probably skewed. Rodents are underrepresented. Obviously, rabbits and artiodactyls formed part of the subsistence base and may have been procured opportunistically. The skeletal part representations for cottontail and jackrabbit are similar, suggesting similar treatment of the carcasses (Table 14.8, Figures 14.7 and 14.8). Skull and foot elements represent butchering debris. If the absence or paucity of trunk elements is not the result of trampling or recovery techniques, it probably represents carcass processing and consumption (see above). The paucity of artiodactyl remains suggests Features 1 (probably Formative period) and 2 are not contemporary. In addition, the smaller size of the Feature 2 faunal assemblage may reflect a shorter occupation. An AMS radiocarbon date obtained during the present project dates Feature 2 (cal A.D. 230–390) to the Archaic IV.

14.3.1.3 Feature 3

The Feature 3 archaeofaunal assemblage consists of 318 specimens. Although smaller, the taxonomic composition is similar to that of Feature 1 (Table 14.2). The turkey-size bird bone (n=1) is a complete calcined phalanx that may represent a waterfowl attracted to the water of Laguna Plata. The box turtle specimen (n=1) is a carapace fragment. Both taxa are considered cultural. The prairie dog specimen is a proximal radius and the pocket gopher specimens (n=2) are a mandible and an associated tooth. The paucity of the rodent remains precludes determination of their use as supplemental meat resources. Except for the calcined phalanx, none of the specimens is burned or gnawed or has butchering marks.

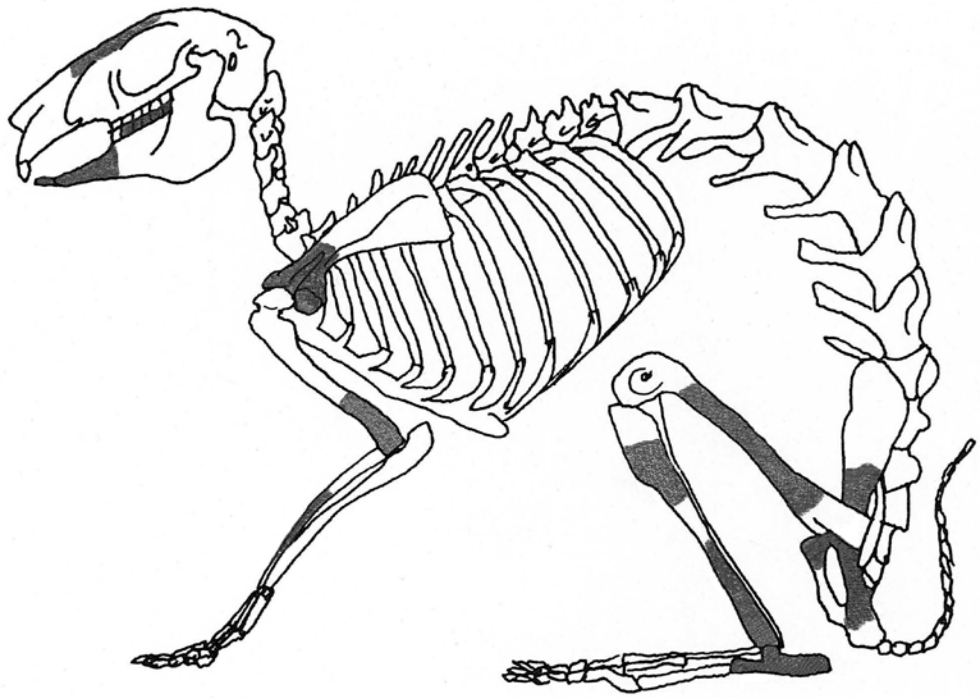

Figure 14.7   Cottontail skeletal part representation, Feature 2, LCAS excavations

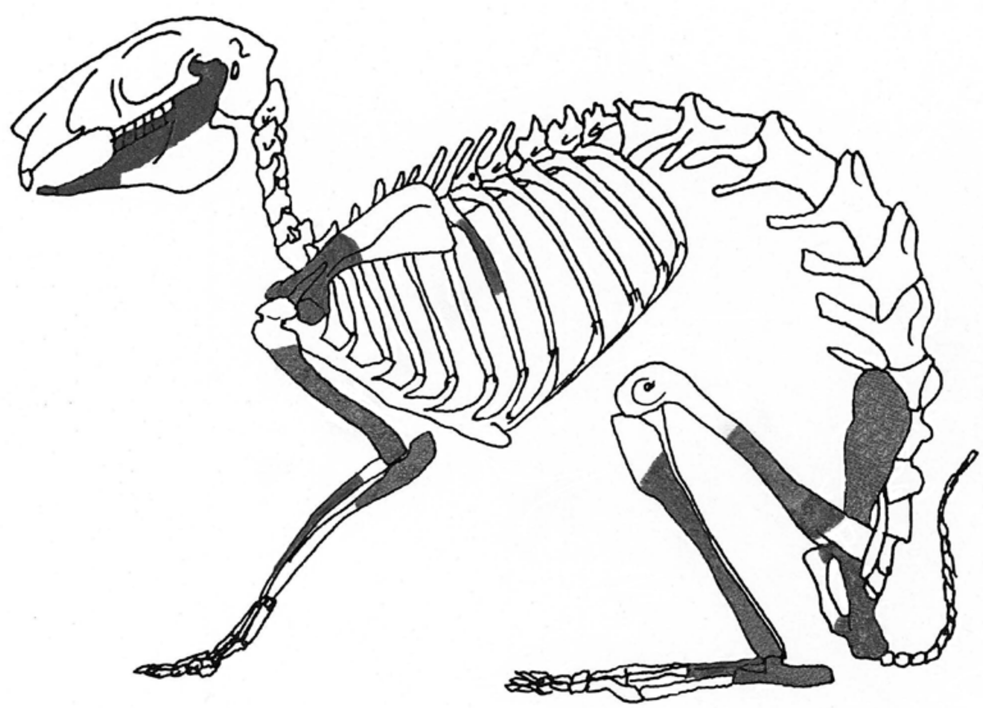

Figure 14.8   Jackrabbit skeletal part representation, Feature 2, LCAS excavations

Like the other features, most of the identified remains (n=170) are those of leporids (n=129, 75.9 percent) (Table 14.2). The Leporidae specimens consist of two rib fragments, a femur shaft fragment, and two complete first phalanges. Except for the absence of cottontail trunk elements and the near absence of foot elements, the skeletal part representations for cottontail and jackrabbit are similar (Table 14.11, Figures 14.9 and 14.10). Both high and low meat value elements indicative of butchering and consumption refuse are present. The incidence of burning (n=7, 5.4 percent) and gnawing (n=12, 9.3 percent) is low (Table 14.12). No butchering marks were identified and none of the bones is worked.

The artiodactyls remains (n=36) include deer, pronghorn, and probable bison (Table 14.2). Most of the artiodactyl skeleton, however, is poorly represented (Table 14.13). Except for a metatarsal fragment, the deer remains (n=4) are high meat value elements indicative of food refuse. Most of the pronghorn remains (n=23) are low meat value skull elements (n=19, 82.6 percent), indicative of butchering debris, as is the astragalus. The ulna is from an immature individual. The deer/pronghorn specimens (n=4) represent both low and high meat value elements. The probable bison remains consist of five tooth fragments, which have no food value. Charring is only present on two pronghorn bones. None of the other artiodactyl remains is burned and the incidence of gnawing is low (n=2, 5.6 percent) (Table 14.12). No butchering marks or worked bones are present.

Most of the rabbit-size specimens (n=69) consist of long bone shaft fragments (n=62, 89.9 percent). The others (n=7) are indeterminate fragments. Nine shaft fragments are charred and five exhibit rodent gnawing (Table 14.12). One long bone shaft fragment exhibits a transverse groove on the exterior surface. Although inconclusive, the specimen may represent bone bead manufacturing that failed at an early stage in the process. Only three coyote-size bones—long bone shaft fragments—are present, of which one is charred and one is rodent gnawed (Table 14.12). The pronghorn-size remains (n=68) consist of skull (n=1), vertebra (n=1), rib (n=2), long bone shaft (n=17), and indeterminate fragments (n=47), of which one is charred, two are calcined, and three exhibit rodent gnawing (Table 14.12). The bison-size specimens (n=8) are long bone shaft fragments without burning or gnawing. One bone has two conchoidal flake scars on the exterior surface along one edge. The specimen is probably associated with breaking a long bone shaft to access the marrow. None of the indeterminate mammal bones exhibit butchering marks.

Table 14.11 Leporid skeletal elements from Feature 3, LCAS excavations

Element	Leporidae	Cottontail	Jackrabbit	Total
Skull:				
Mandible		1	4	**5**
Teeth		3	1	**4**
Trunk:				
Cervical Vertebra			1	**1**
Lumbar Vertebra			1	**1**
Rib	2		2	**4**
Foreleg:				
Scapula		1	9	**10**
Humerus		3	10	**13**
Radius		1	11	**12**
Ulna			2	**2**
Hindleg:				
Innominate		2	4	**6**
Femur	1	7	13	**21**
Tibia		12	16	**28**

Element	Leporidae	Cottontail	Jackrabbit	Total
Feet:				
Metacarpals			1	**1**
Calcaneum			6	**6**
Metatarsals		3	8	**11**
1st Phalanx	2		2	**4**
Total	**5**	**33**	**91**	**129**

Table 14.12 Burned and gnawed taxa from Feature 3, LCAS excavations

Taxon	NISP	Burned		Gnawed
		CH	CAL	R
Indeterminate large bird (Turkey-size)	1		1	
Leporidae (Rabbits, Hares)	5			2
Sylvilagus audubonii (Desert Cottontail)	33			5
Lepus californicus (Black-tailed Jackrabbit)	91	7		5
Odocoileus sp. (Deer)	4			1
Antilocapra americana (Pronghorn)	23	2		1
Indeterminate small mammal (rabbit-size)	69	9		5
Indeterminate medium mammal (coyote-size)	3	1		1
Indeterminate large mammal (pronghorn-size)	68	1	2	3
Total	**297**	**20**	**3**	**23**

CH = charred, CAL = calcined; R = rodent

Table 14.13 Artiodactyl skeletal elements from Feature 3, LCAS excavations

Element	Deer	Pronghorn	Deer/ Pronghorn	Bison	Total
Skull:					
Parietal			1		**1**
Maxilla/Mandible		2	1		**3**
Teeth - Complete		1			**1**
Teeth - Fragments		16		5	**21**
Trunk:					
Thoracic Vertebra			1		**1**
Lumbar Vertebra	1				**1**
Rib			1		**1**
Foreleg:					
Humerus	1				**1**
Ulna		1			**1**
Hindleg:					
Innominate	1	2			**3**
Feet:					
Astragalus		1			**1**
Metatarsals	1				**1**
Total	**4**	**23**	**4**	**5**	**36**

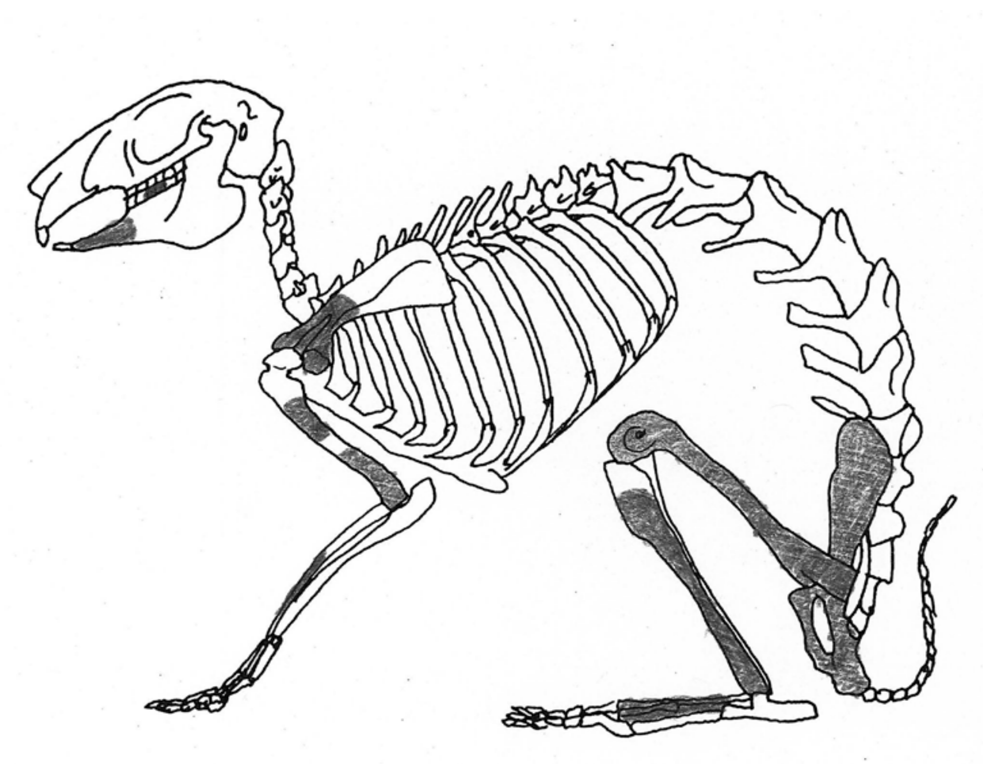

Figure 14.9 Cottontail skeletal part representation, Feature 3, LCAS excavations

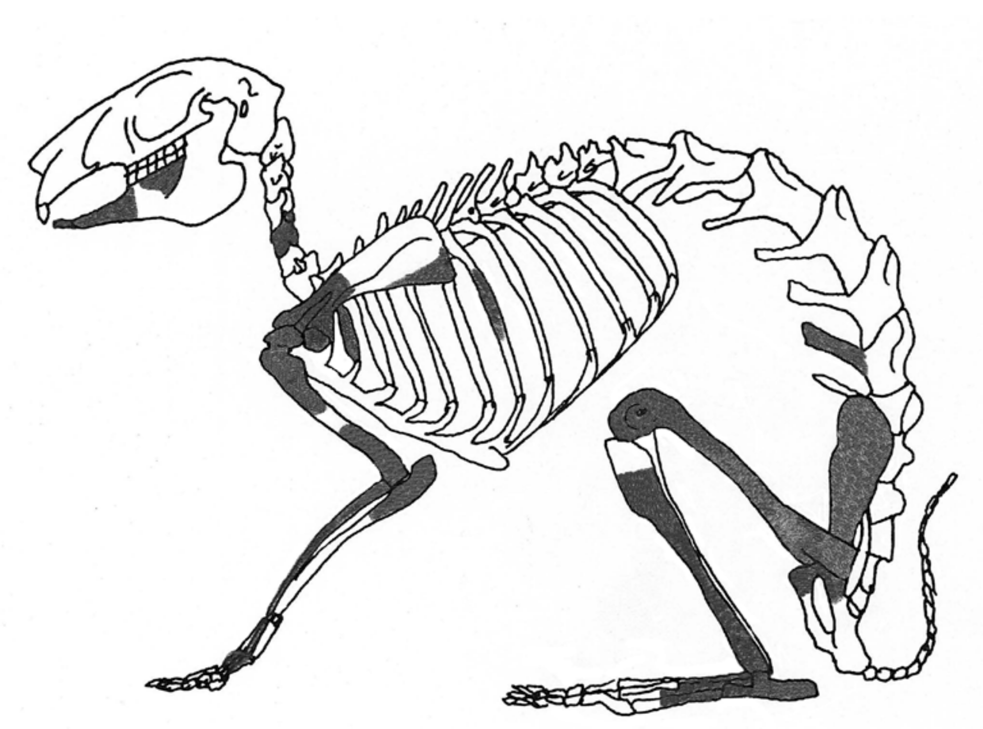

Figure 14.10 Jackrabbit skeletal part representation, Feature 3, LCAS excavations

14.3.1.3.1 *Discussion*

Like Features 1 and 2, the faunal assemblage of the Feature 3 pit structure is skewed. Rodents are underrepresented. Given the setting of the site, rabbits and artiodactyls may have been procured opportunistically. The skeletal part representations for cottontail and jackrabbit suggest carcass treatment for both animals was the same (Table 14.11, Figures 14.9 and 14.10). Although artiodactyl remains are scarce, the presence of both low and high meat value elements suggests the animals were either killed and initially butchered near the site at the kill locus, with final processing occurring at the site, or entire carcasses were brought to the site, with butchering, final meat processing, and consumption—and associated refuse disposal—occurring in different portions of the site. Two AMS dates obtained during the present project—cal A.D. 1040–1220 and cal A.D. 1040–1260—date Feature 3 to the Formative III–VI, suggesting Features 1 and 3 are contemporaneous.

14.3.1.4 Midden

The LCAS midden assemblage consists of 101 specimens (Table 14.2). The taxonomic composition of the assemblage is similar to that of the features, in terms of economic taxa, but with slightly fewer overall taxa. The assemblage does not contain any rodents. The western box turtle is represented by an indeterminate shell fragment. It is not burned nor exhibits evidence of gnawing. As usual, most of the identified remains (n=24) are leporid (n=20, 83.3 percent) (Table 14.2). The Leporidae specimens (n=2) consist of a complete and nearly complete first phalanx. Unlike the skeletal part representation for jackrabbit, cottontail skull and foot elements are absent, and except for a scapula fragment, foreleg elements are missing (Table 14.14). All of the cottontail remains are high meat value elements representing food refuse. The jackrabbit remains are both low and high meat value elements indicative of butchering and consumption refuse. None of the rabbit remains is burned, but one jackrabbit and two cottontail bones have discernible rodent gnawing (Table 14.15). None has butcher marks or is gnawed.

The midden assemblage contains few artiodactyl remains (n=3) (Table 14.2). Skeletal part representation, therefore, is poor (Table 14.16). The specimens, proximal portions of the lower legs, are high meat value elements indicative of food refuse. None of the remains is burned, gnawed, or worked, or has butchering marks (Table 14.15).

All of the rabbit-size specimens (n=14) consist of long bone shaft fragments. The coyote-size specimen is an indeterminate fragment. The majority of the indeterminate mammal remains (n=77) are those of pronghorn-size mammals (n=61, 79.2 percent) and consist of rib shaft (n=3), long bone shaft (n=17), and indeterminate (n=41) fragments. Three are charred and one exhibits rodent gnawing (Table 14.15). The bison-size specimen is a rib shaft fragment, a high meat value element indicative of food refuse. None of the indeterminate mammal remains is worked or exhibits butchering marks.

Table 14.14 Leporid skeletal elements from the midden, LCAS excavations

Element	Leporidae	Cottontail	Jackrabbit	Total
Skull:				
Squamosal			1	**1**
Foreleg:				
Scapula		1	1	**2**
Humerus			3	**3**
Hindleg:				
Innominate		1		**1**
Femur		2	3	**5**
Tibia		1	2	**3**

Element	Leporidae	Cottontail	Jackrabbit	Total
Feet:				
Calcaneum			2	**2**
Metatarsals			1	**1**
1st Phalanx	2			**2**
Total	**2**	**5**	**13**	**20**

Table 14.15 Burned and gnawed taxa from the midden, LCAS excavations

Taxon	NISP	Burned	Gnawed
		CH	R
Sylvilagus audubonii (Desert Cottontail)	5		2
Lepus californicus (Black-tailed Jackrabbit)	13		1
Indeterminate large mammal (pronghorn-size)	61	3	1
Total	**79**	**3**	**4**

CH = charred, R = rodent

Table 14.16 Artiodactyl skeletal elements from the midden, LCAS excavations

Element	Deer	Deer/ Pronghorn	Total
Foreleg:			
Ulna	1	1	**2**
Hindleg:			
Tibia		1	**1**
Total	**1**	**2**	**3**

14.3.1.4.1 *Discussion*

The LCAS archaeofaunal assemblage from the midden is a smaller reflection of the feature assemblages, but without the rodents. The frequency of burning (n=3), 3 percent of the entire midden assemblage, is low. This suggests the midden was not frequently used for disposal of hearth cleaning debris or hearth refuse. Both butchering debris and food refuse, however, were discarded in the midden. The fragmented condition of the pronghorn-size remains, especially the long bone shaft fragments, may reflect marrow extraction.

14.3.1.5 Other Units

The LCAS archaeofaunal assemblage from other units outside Features 1, 2, 3, and the midden consists of 26 specimens, half of which are leporids (n=13, 50 percent) (Table 14.2). The Leporidae specimen is a rib shaft fragment and the cottontail bone is a proximal ulna fragment. Most of the leporid remains are those of jackrabbit (n=11, 84.6 percent) and except for trunk elements, the main portions of the skeleton are represented (Table 14.17). The premaxilla and feet elements have low meat value, while the foreleg and hindleg elements are higher meat value portions. The paucity of leporid cranial and trunk elements may be attributed to a combination of field recovery methods (use of ¼-inch screens) and food preparation methods by the site inhabitants (see above). The foot elements represent butchering refuse. None of the rabbit remains is burned or worked or has butchering marks, but a jackrabbit tibia and metatarsal exhibit rodent-gnawing (Table 14.18). The only other identified specimen is the distal shaft of a deer/pronghorn ulna (Table 14.19). The upper foreleg has higher meat value compared to the lower leg and this portion of the ulna has a lower meat value than the proximal portion and may represent butchering or processing refuse. The specimen is not burned, gnawed, or worked, and it does not have butchering marks.

All of the rabbit-size remains (n=7) are long bone shaft fragments, of which one has rodent gnawing (Table 14.18). The pronghorn-size specimens (n=5) consist of three indeterminate fragments, one of which is calcined, and two long bone shaft fragments, one of which is modified. The modified specimen is the distal portion of an awl with a pointed tip (Figure 14.11). It was found on the surface and is eroded and sun-bleached and has longitudinal drying cracks. The awl is 7.1 mm long and the shaft is 1.15 mm wide and 0.42 mm thick.

Figure 14.11 Awl fragment, other units, LCAS excavations

14.3.1.5.1 *Discussion*

Overall, the assemblage from other units is represented primarily by leporids and rabbit-size remains, with no turtles, rodents, or very large artiodactyls (e.g., bison) present. Although the assemblage does not have the species diversity exhibited in the features and midden, The types of bone refuse—butchering, processing, and consumption/food—are similar.

Table 14.17 Leporid skeletal elements from other units, LCAS excavations

Element	Leporidae	Cottontail	Jackrabbit	Total
Skull:				
Premaxilla			1	**1**
Trunk:				
Rib	1			**1**
Foreleg:				
Humerus			3	**3**
Radius			1	**1**
Ulna		1		**1**
Hindleg:				
Femur			1	**1**
Tibia			2	**2**
Feet:				
Calcaneum			1	**1**
Metatarsals			2	**2**
Total	**1**	**1**	**11**	**13**

Table 14.18 Burned and gawed taxa from other units, LCAS excavations

Taxon	NISP	Burned	Gnawed
		CAL	R
Lepus californicus (Black-tailed Jackrabbit)	11		2
Indeterminate small mammal (rabbit-size)	7		1
Indeterminate large mammal (pronghorn-size)	5	1	
Total	**23**	**1**	**3**

CAL = calcined, R = rodent

Table 14.19 Artiodactyl skeletal elements from other units, LCAS excavations

Element	Deer/ Pronghorn	Total
Foreleg:		
Ulna	1	**1**
Total	**1**	**1**

14.3.2 The 2010 Assemblage

The faunal assemblage recovered during TRC's 2010 excavations consists of 38 specimens from Feature 2 (TU1 and TU7) and 2 specimens from Feature 3 (TU 2) (Table 14.1). Identified remains from the Feature 2 units consist of a calcined turtle carapace fragment and a pronghorn tooth fragment. Rabbit-size bones (n=20) consist of 16 long bone shaft fragments and four indeterminate fragments. The incidence of burning is high (n=13, 65 percent), with four charred and nine calcined. All of the coyote-size (n=13) and pronghorn-size (n=3) specimens consist of indeterminate fragments, of which two of the former and each of the latter are calcined. The presence of sun-bleached specimens in the Feature 2 assemblage indicates former exposure on the ground surface for a prolonged period. None of the remains is gnawed or worked or has butchering marks. Little can be ascertained from the faunal assemblage other than the assemblage appears to represent food refuse and the pit structure fill may represent a refuse midden that contains hearth cleaning debris, as evidenced by the calcined specimens.

The Feature 3 assemblage consists of a pronghorn tooth fragment and a calcined rabbit-size long bone shaft fragment. The paucity of the remains precludes any meaningful interpretations beyond the fact that hearth cleaning debris was deposited in the fill.

14.3.3 The 2010 Off-site Assemblage

A small vertebrate faunal assemblage recovered from an exploratory off-site backhoe trench (TR6) east of the site, around the periphery of the Laguna Plata, consists of 13 specimens, of which one is a pronghorn-size long bone shaft fragment and seven are bison-size long bone shaft fragments (Table 14.1). Identified specimens consist of three bison tooth fragments and two rib shaft sections of a probable bison, of which one has rodent gnawing and the other has both rodent and carnivore gnawing. In addition, the medial surface of the rib with rodent gnawing only has a transverse defleshing cut mark in which a small dark chert fragment is embedded.

The presence of bison off-site indicates Laguna Plata playa attracted game animals and formerly, may have been a more perennial water source fed by springs and seeps. The bison rib with the cut mark also suggests bison were probably procured opportunistically when attracted to the water and vegetation of the playa. Collagen dating of a bison bone fragment yielded an AMS date of cal A.D. 1510–1800, indicative of the Ethnohistoric I–II.

14.4 Seasonality

The LA 5148 faunal assemblage is indicative of a diffuse hunting strategy consisting of the procurement of both small game, particularly leporids, and larger game—deer, pronghorn, and bison. The presence of low and high meat value elements for each of these animals indicates all were available locally. Leporids, prairie dogs, pocket gopher, and woodrats are r-selected species. Although they contain much less meat than deer or pronghorn, they are more reliable meat resources. They have high reproductive rates and, during good weather, breed nearly all-year in southeastern New Mexico. The high mortality rate for leporids is offset by a high reproductive rate (see Natural History and Ethnographic Background). Because of the long breeding season of leporids in southeastern New Mexico, use of ages based on long bone epiphyseal fusion rates is not a reliable method for determining seasonality. The leporid remains from LA 5148, therefore, do not lend themselves to providing reliable information about seasonality of site occupation.

Artiodactyls are K-selected species and are more susceptible to predation and environmental change compared to r-selected species. Mule deer breed from late fall to early winter. The gestation period is almost seven months. In New Mexico, most fawns are born in June or July (Findley 1987:139–140; Hoffmeister 1986:542). None of the deer remains from LA 5148 provide information about seasonality of site occupation. The represented elements are fragmented and do not include the necessary portions pertinent for aging and seasonality. Many of the deer remains consist of tooth fragments and enamel. However, the general size, thickness, and texture of the deer bone fragments are indicative of larger, probably mature or nearly mature, individuals.

Pronghorn breed in the fall. Does give birth, usually to twins, in mid-June (Findley 1987:144–145; Hoffmeister 1986:549, 551–552; Zeveloff 1988:334–336). Like the deer remains, none of the pronghorn elements recovered from LA 5148 provide information about seasonality of site occupation. Also like the deer, many of the pronghorn specimens are tooth and enamel fragments. However, the general size, thickness, and texture of the pronghorn bone fragments are indicative of larger, probably mature or nearly mature, individuals.

During the breeding season, from mid- to late summer, bison males join the female-subadult herds. After a gestation period of about 9.5 months, a single precocial calf per breeding female is usually born in the spring. Occasionally, a female may have twins (Bee et al. 1981:229–230; Findley 1987:146; Zeveloff 1988:346–347). Unfortunately, the definitive bison remains from LA 5148 are long bone and tooth fragments that are not conducive to providing information about seasonality of site occupation. However, the general size, thickness, and texture of the bison bone fragments are indicative of larger, probably mature or nearly mature, individuals.

14.5 Intersite Comparisons

Seven sites—LA 109476, LA 120945, LA 34150, LA 68182, LA44565, LA 116471, and LA 68188—were selected to compare with the LCAS assemblage from LA 5148, Laguna Plata. Because of the differences in field methods and data recovery techniques, it is difficult to generate meaningful comparisons. Studies (e.g., James 1997:386; Shaffer 1992; Shaffer and Sanchez 1994) have shown that as much as 100 percent of the fish, 95 percent of the small animals (rodents, birds, amphibians, reptiles), 86 percent of the small mammals (e.g., squirrels and chipmunks), 71 percent of the lagomorphs, and 47 percent of the medium (coyote-size) mammals are lost through use of ¼-inch screens. In comparison, no artiodactyl bones are lost using ¼-inch screen (Akins 2002:133). The Laguna Plata (LA 5148) LCAS assemblage is known to have been recovered using ¼-inch screen, but whether all discernible animal bones were collected is not known, given the variable skills and inclinations of the excavators in 1970. The following is a brief description of each site.

LA 109476 dates to Leslie's (1979) Maljamar phase, A.D. 1150–1300 (Yoder 1998:106). The site is in the Mescalero Sands, about 56 km (35 mi) east of Roswell and the Pecos River and 8 km (5 mi) northwest of the Caprock. The site was probably a short-term camp for a small group of Formative period hunter-gatherers using the resources of the eastern portion of the Mescalero Sands. Much of the faunal assemblage likely represents intrusive taxa that are non cultural (Brown 1998:144–145; Yoder 1998:106).

LA 120945, Laguna Gatuna, is a Late Eastern Jornada Mogollon site dating from about A.D. 900–1400. The site is situated on the south side of Laguna Gatuna, about 8 km (5 mi) southeast of the Laguna Plata site. LA 120945 is in a comparable environment as Laguna Plata. Laguna Gatuna is about 33 miles east of the Pecos River and 27 miles west of the Caprock. Excavations yielded prehistoric artifacts but no discernible features (Akins 2001:46–58; Bullock 2001).

LA 34150, Townsend, is a Late Archaic to Late Eastern Jornada Mogollon residential occupation dating from about 1800 B.C.–A.D. 1400. The site is on the south side of Salt Creek, about 10 miles north of Roswell and 8 miles west of the Pecos River. Excavations yielded prehistoric artifacts and features. The site assemblage in the following comparisons is separated into five areas: Townsend East Area A (Early Ceramic with some Late Archaic), Townsend East Area B (Late Ceramic), Townsend East Area C (Late Archaic), Townsend West Pit, and Townsend Bison area. Because the faunal assemblages are distinct for each of these loci they are maintained as separate comparative units in the following discussion (Akins 2003a:263–278).

LA 68182, Los Molinos, has Late Archaic to Late Eastern Jornada Mogollon occupations dating from about 300 B.C.–A.D. 1350. The site is on the north side of the Middle Berrendo Creek, about 4 miles north of Roswell and 7.6 miles west of the Pecos River. The assemblage represents a diverse and opportunistic hunting strategy with evidence of hunting beyond the immediate site environs, but may represent an amalgamation of both because of the occupation time span involved (Akins and Moga 2004:111).

LA 44565, Rocky West, represents a Middle Archaic to Late Archaic camp site dating from about 3000 B.C.–A.D. 200. The site, between Carlsbad and Seven Rivers along Rocky Arroyo, is about 1.5 miles west of the Pecos River. The faunal assemblage indicates the site was a locus where local wildlife was consumed and the refuse was deposited into a fire. Lagomorphs and small mammals dominate the assemblage (Moga 2003:111). The presence of domesticated sheep or goat within the assemblage indicates it may be a historic trash scatter with a shallowly buried prehistoric component (Moga 2003:116).

LA 116471, Punto de Los Muertos, has occupations dating from Late Archaic through Late Eastern Jornada Mogollon, or ca. 500 B.C.–A.D. 1400. The site, immediately northwest of Carlsbad at the east side of Living Desert State Park, is at the western edge of the Pecos River Valley, immediately west of the river. Excavation focused on a burned midden ring (Feature 1). A sizeable faunal assemblage was recovered, much of which is burned. In addition, the fragmented and burned remains of 12–13 humans were recovered from the ring midden. The feature had been previously disturbed by extensive unauthorized digging which contributed to the deterioration of the faunal assemblage and context of the cultural deposits (Akins 2003b:129–130).

LA 68188, The Fox Place, is an Eastern Jornada Mogollon residential complex dating from about A.D. 1150–1400. The site is on the east side of the Rio Hondo, about 3.2 km (2 mi) southwest of Roswell and 16 km (10 mi) west of the Pecos River. Excavations yielded a large assemblage of nearly 60,000 faunal remains of which 25,615 specimens from 28 features were analyzed (Akins 2002:133–289). The taxonomic composition of the assemblage is very diverse, reflecting the birds, fish, and turtles living in or migrating through the area (Akins 2002:155). In addition, NISP, MNI and taxonomic richness studies have repeatedly shown a strong correlation between the size of the assemblage and the diversity of taxa identified (e.g., M. Brown and K. Brown 1993:327–336; K. Brown and M. Brown 1998:134–149). Exceptions to this association would be specialized procurement sites such as bison and pronghorn kill loci (e.g., Garnsey bison kill site [Speth 1983]).

Although not used in the following analysis, the Garnsey site (LA 18399), a mid- to late fifteenth century bison kill on the eastern edge of the Pecos River Valley, about 20 km (12 mi) southeast of Roswell in Chaves County, is an example of a specialized bison kill locus. The bison remains were exposed in the walls of a modern arroyo that is actively cutting into the alluvial fill of Garnsey Wash, a broad, shallow wash that drains westward into the Pecos River from a low divide at the Caprock. The local terrain consists of low, rolling plains with extensive dunes and numerous playas (Speth 1983:6–7). The Garnsey site is not used in the following assemblage comparisons because it represents a specialized activity that focused on bison procurement and processing. Interestingly, results of analyses indicate procurement was highly selective, with a high proportion of males (60 percent) compared to cows and calves (Speth 1983:160, 165). The intensity of butchering suggests food insecurity. Speth (1983:169) speculates, "food insecurity may have been the norm rather than an infrequent or seasonal problem." The Garnsey bison exhibited a high rate of dental attrition and short life expectancy, in addition to subsisting, based on carbon isotope data, on extremely marginal and progressively deteriorating vegetal resources (Speth 1983:169). It is likely that during the mid-1450s the local bison populations were very vulnerable to climatic fluctuations that altered the vegetation. Bison procurement would have been variable and unpredictable from year to year, thus bison hunting would have been opportunistic (Speth 1983:170).

Table 14.20 summarizes the taxa recovered from each of the assemblages. The taxa list is a composite of taxa listed within each of the reports. In a few instances the present taxonomic name is used rather than the former name.

The archaeofaunal remains from LA 5148, LA 44565, LA 68182, LA 34150 Area A, Area B, West Pit, LA 120945, LA 68188, and LA 116471 have the look of garden hunting assemblages. The assemblages are dominated by small mammals, particularly leporids, and may reflect the exploitation of animals attracted to cultivated fields. The occurrence of a garden hunting assemblage highlights the importance of small game hunting during the transition from a strictly hunter-gatherer lifeway to reliance on agriculture. In contrast, the small LA 109476 assemblage reflects hunting of large game, including deer/pronghorn.

In general, as the commitment to agriculture and sedentism increased in the Southwest, the procurement of small mammals, especially leporids, assumed more importance in subsistence strategies (Szuter and Gillespie 1994). If this is the case, the archaeofaunal assemblages herein should reflect an increase in the proportion of small mammals relative to large mammals during the prehistoric time span represented by the assemblages' Archaic through Late Eastern Jornada Mogollon occupations. Because the assemblages are associated with intensive agricultural development and reliance on crops, they should contain a much higher proportion of small mammals. The presence of artiodactyls is also high in LA 68182, LA 34150 Area A, Area B, West Pit, Bison Area, and LA 68188 (Table 14.20).

Two indices are used for inter-site comparisons (Table 14.21). First, the leporid index (Bayham 1982) is calculated for the eight sites. The leporid index is a standardized ratio for examining the proportion of cottontails to jackrabbits in an archaeofaunal assemblage. It is calculated by dividing the total number of cottontail remains (NISP) by the total leporid remains (NISP). Values greater than 0.5 indicate relatively more cottontails are represented and those less than 0.5 indicate greater jackrabbit representation. The lagomorph index for LA 5148 is 0.28, which is indicative of an emphasis on jackrabbit procurement, while the index of 1.0 for LA 109476 indicates cottontail exclusively.

Table 14.20 Summary table of site taxa

Taxon	Common Name	LA 5148 Laguna Plata LCAS 1970	LA 5148 Laguna Plata 2010	LA 5148 Laguna Plata Off-site 2010	LA 44565 Rocky West	LA 68182 Los Molinos	LA 34150 Townsend East Area A: Early Ceramic w/Late Archaic	LA 34150 Townsend East Area B: Late Ceramic	LA 34150 Townsend East Area C: Late Archaic	LA 34150 Townsend West Bison Area	LA 34150 Townsend West Pit	LA 120945 Laguna Gatuna	LA 68188 Fox Place	LA 109476	LA 116471 Punto de Los Muertos
Pelecypods	freshwater mussels						107	80	1			9	576		400
Crytonaias tampicoensis	Pecos pearly mussel						2								
Gastropod	snail				2										
Crayfish	crayfish												1		
Osteichthyes	Fish						7	1					443		
Salmo sp.	Trout												1		
Castostomidae	Sucker												105		
Maxostama cf. *congenstum*	Gray redhorse												226		
Cydeptus elongatus	Blue sucker												3		
Ictiobus bubalus	Small-mouth buffalofish												6		
Cyprinidae	Minnow												1		
Ictaluridae	Catfish												353		1
Ictalurus sp.	Catfish species												33		
Ictalurus punctatus	Channel catfish												205		
Ictalurus lupus	Headwater catfish												48		
Pylodictis olivaris	Flathead catfish												14		
Ameiurus sp.	Bullhead catfish												6		
Centrarchidae	Sunfish/ bass												14		
Lepamis sp.	Sunfish												45		
Micropterus cf. *punctulatus*	Spotted bass												15		
Squamata	Lizards and snakes												1		
Sauria	Lizard											2			7
Phrynosoma sp.	Horned lizards				2	3							1		
Cnemidophorus sp.	Whip-tailed lizard						1								
Ophidia	Snakes						1	5							
Colubridae	Nonvenomous snakes	1			1	7	1					2	7	1	2
cf. *Pituophis melanoleucus*	Gopher snake													3	
Crotalus atrox	Western diamondback												1		
Salienta	Frogs/ toads					3							5		
Bufonidae	Toads												4		
Spea bombifrons	Plains spadefoot toad					1							1		
Ranidae	Frogs												1		

Taxon	Common Name	LA 5148 Laguna Plata LCAS 1970	LA 5148 Laguna Plata 2010	LA 5148 Laguna Plata Off-site 2010	LA 44565 Rocky West	LA 68182 Los Molinos	LA 34150 Townsend East Area A: Early Ceramic w/Late Archaic	LA 34150 Townsend East Area B: Late Ceramic	LA 34150 Townsend East Area C: Late Archaic	LA 34150 Townsend West Bison Area	LA 34150 Townsend West Pit	LA 120945 Laguna Gatuna	LA 68188 Fox Place	LA 109476	LA 116471 Punto de Los Muertos
Rana berlandieri	Rio Grande leopard frog												1		
Testudinata	Turtles and tortoises				1	149	7						172		62
Trionyx sp.	Softshell turtles						1								
Trionyx spineferus	Spiny softshell turtle					16							36		7
Trachemys/ Pseudomys	Slider														3
Trachemys scripta	Pond slider					2							17		8
Pseudomys gorzugi	Western river cooter					1							3		
Testudinidae	Box and water turtles		1			2									
Terrapene ornate	Ornate box turtle	22				3	5						22		
cf. *Terrapene ornate*	Ornate box turtle											1			
Chrysemys sp.	Painted turtle				1										
Chrysemys picta	Painted turtle					1							100		1
Chelydridae	Snapping, musk, mud turtles					1									
Chelydra serpentina	Snapping turtle					6							154		
Kinosternon flavescens	Mud turtle					135							36		
Aves	Birds					15							796		
Branta canadensis	Canada goose												1		
Anatinae	Ducks					2									
Aix spansa	Wood duck												4		
Anatini	Surface-feeding ducks												3		
Anas discors	Blue-winged teal												3		
Anas platyrhynchos	Mallard												14		
Anas dypeata	Northern shoveler												5		
Aythyinae	Diving ducks												2		
Aythya affinis	Lesser scaup												4		
Melanitta deglandi	White-winged scoter												1		
Mergus merganser	Common merganser												13		
Cathartes aura	Turkey vulture												1		
Accipitridae	Kites, eagles, hawks, harriers				2										
Pandion haliaetus	Osprey												44		
Haliaetus leucocephalus	Bald eagle												2		

Taxon	Common Name	LA 5148 Laguna Plata LCAS 1970	LA 5148 Laguna Plata 2010	LA 5148 Laguna Plata Off-site 2010	LA 44565 Rocky West	LA 68182 Los Molinos	LA 34150 Townsend East Area A: Early Ceramic w/Late Archaic	LA 34150 Townsend East Area B: Late Ceramic	LA 34150 Townsend East Area C: Late Archaic	LA 34150 Townsend West Bison Area	LA 34150 Townsend West Pit	LA 120945 Laguna Gatuna	LA 68188 Fox Place	LA 109476	LA 116471 Punto de Los Muertos
Circus cyaneus	Northern harrier												2		
Accipiter cooperii	Cooper's hawk												1		
Buteo sp.	Broad-winged hawks												2		
Buteo jamaicensis	Red-tailed hawk												2		
Buteo lagopus	Rough-legged hawk												1		
Falco sparverius	Sparrow hawk												1		
Phasianidae	Quails, partridges, pheasants				1									39	
Gallus gallus	Domestic chicken				1										
Colinus virginianus	Bobwhite														2
Meleagris gallopavo	Turkey					4							317		
Tetraonidae	grouse and ptarmigan												5		
Callipepla gambelii	Gambel's quail												3		1
Callipepla squamata	Scaled quail												8		1
Fulica americana	American coot					2							84		
Tympanuchus pallidicinctus	Lesser prairie chicken												18		
Columbidae	Pigeons and doves					1									
Bubo virginianus	Great horned owl												1		
Melanerpes erythrocephalus	Red-headed woodpecker												1		
Passeriformes	Perching birds				1	2							1		
Eremophila alpestris	Horned lark												1		
Corvus corax	Raven												1		
medium bird	quail-size						2								4
large bird	duck/hawk-size						1								4
very large bird	turkey/goose-size	1													1
egg shell							10	2				1	120		
Leporidae	Rabbits	37				1							11		
Sylvilagus audubonii	Desert cottontail	166			63	401	129	32			41	16	2456	4	148
Lepus californicus	Black-tailed jackrabbit	390			39	163	47	17			9	12	1417		148
Rodentia	Rodents					9							28		
Spermophilus sp.	Ground squirrels					3							6		
Cynomys ludovicianus	Black-tailed prairie dog	17			4	291	33	17			3		998		13
Geomyidae	Pocket gophers					9							3		
cf. *Geomys* sp.	Pocket gopher														2

Taxon	Common Name	LA 5148 Laguna Plata LCAS 1970	LA 5148 Laguna Plata 2010	LA 5148 Laguna Plata Off-site 2010	LA 44565 Rocky West	LA 68182 Los Molinos	LA 34150 Townsend East Area A: Early Ceramic w/Late Archaic	LA 34150 Townsend East Area B: Late Ceramic	LA 34150 Townsend East Area C: Late Archaic	LA 34150 Townsend West Bison Area	LA 34150 Townsend West Pit	LA 120945 Laguna Gatuna	LA 68188 Fox Place	LA 109476	LA 116471 Punto de Los Muertos
Thomomys bottae	Botta's pocket gopher														1
Pappogeomys castanops	Yellow-faced pocket gopher	8				19	4						300		2
Geomys bursarius	Pains pocket gopher					2					3		2		
Dipodomys sp.	Kangaroo rat														3
Dipodomys ordii	Ord's kangaroo rat							2			1			20	
Dipodomys spectabilis	Banner-tailed kangaroo rat					8	2						2		5
Cricetinae	New World mice and rats														2
Onychomys leucogaster	Northern grasshopper mouse					2		1							
Castor Canadensis	Beaver												1		3
Sigmodon hispidus	Hispid cotton rat					3							1		5
Neotoma sp.	Woodrat	1				10	1						11		20
Neotoma albigula	White-throated woodrat														2
Ondatra zibethicus	Muskrat					35							67		
Erethizon dorsatum	Porcupine					1							5		
Carnivora	Carnivores												2		
Canis sp.	Dogs, coyotes, wolves, foxes					28		1					158		1
Canis lupus	Wolf												1		
Vulpes vulpes	Red fox												8		
Urocyon cinereoargenteus	Gray fox												4		
Procyon lotor	Raccoon	1				1							3		
Mustelidae	Weasels, skunks, relatives					1									
Taxidea taxus	Badger							1				1	13		
Mephitis mephitis	Striped skunk					6							2		
Artiodactyla	Even-toed ungulates					558	18	5	1		40		760		4
cf. *Cervus elaphus*	Wapiti							1							
Odocoileus sp.	Deer	8				30	1	1					108		11
Odocoileus hemionus	Mule deer											1	4		
Antilocapra Americana	Pronghorn	129				87							1082		20
cf. *Antilocapra Americana*	Pronghorn	6	2												

Taxon	Common Name	LA 5148 Laguna Plata LCAS 1970	LA 5148 Laguna Plata 2010	LA 5148 Laguna Plata Off-site 2010	LA 44565 Rocky West	LA 68182 Los Molinos	LA 34150 Townsend East Area A: Early Ceramic w/Late Archaic	LA 34150 Townsend East Area B: Late Ceramic	LA 34150 Townsend East Area C: Late Archaic	LA 34150 Townsend West Bison Area	LA 34150 Townsend West Pit	LA 120945 Laguna Gatuna	LA 68188 Fox Place	LA 109476	LA 116471 Punto de Los Muertos
Odocoileus/ Antilocapra Americana	Deer/Pronghorn	66												5	
Bison bison	Bison	3		3		45		2		112			239		
cf. *Bison bison*	Bison	8		2											
Bos/bison	Cow/bison					34	2						2		
Capra hircus	Domestic goat				1										
Ovis/capra	Domestic sheep/goat				15										
very small mammal	rodent-size					1			25					29	5
small mammal or bird	rodent-perching bird-size						7				2	1			
small mammal	rabbit-size	260	21		133	1099	826	118	3		36	72	4102	27	268
unknown small	rabbit-size						9	7				2			
medium mammal	coyote-size	18	13		84	2878	54	32		5	11	12	1959	1	875
large mammal	deer/pronghorn-size	624	3	1	30	3680	39	38		67	6	19	6397	8	5487
very large mammal	bison/wapiti-size	44		7					155	155					1
mammal	undetermined					154							1920	1	

Second, the artiodactyl index (Bayham 1982) is calculated for the eight sites. The artiodactyl index is a standardized ratio for examining the proportion of artiodactyls to leporids in the archaeofaunal assemblages. It is calculated by dividing the total number of artiodactyl remains (NISP) by the combined total of both leporid and artiodactyl remains (NISP). Values greater than 0.5 indicate relatively more artiodactyls are represented (in a standardized ratio), while values less than 0.5 indicate more leporids (in a standardized ratio) are represented. The artiodactyl index for LA 5148 is 0.27, which is indicative of a more focal hunting of leporids, but with artiodactyls also contributing to the diet.

Upon first examination, for LA 5148, the leporid index of 0.28 and artiodactyl index of 0.27 indicate jackrabbits were probably the preferred small game animal, with some procurement of artiodactyls and introduction of the bones into the site in a field-butchered form. As summarized by Quirt-Booth and Cruz-Uribe (1997:957), “horticulture disturbs primary vegetation, creating ‘edge zones’ (new habitats) which support a higher local density of game, particularly small species. Thus, horticulturalists will focus their hunting efforts on small mammals (i.e., leporids) easily taken in agricultural fields.” The low incidence of large mammal remains is suggestive of longer distance hunting, with deer-size animals introduced into the site in a field-butchered form. However, the LA 5148 leporid index of 0.28 may reflect use of ¼-inch screens during excavation (see faunal discussion of LCAS Feature 1 above; Shaffer 1992:131).

Figure 14.12 summarizes the leporid and artiodactyl indices. Sites (and site loci) with high leporid index values (greater cottontail than jackrabbit) include LA 44565 (Rocky West), LA 68182 (Los Molinos), LA 120945 (Laguna Gatuna), LA 68188 (The Fox Place), and LA 34150 (Townsend Area A; Area B; West Pit). LA 116471 (Punto de Los Muertos) has an index of 0.5, and LA 109476 does not have any jackrabbits. LA 5148 (Laguna Plata) has the only index below 0.5. This pattern may reflect local environmental conditions. Jackrabbit prefer open habitat, and cottontail prefer brushy vegetated habitat.

Sites with leporid indices of 0.50 or less and those with indices greater than 0.57 represent different subsistence patterns. In addition to showing differences in emphasis between two different genera as they relate to subsistence, the indices also represent different hunting strategies and are environmental indicators. The desert cottontail inhabits grasslands, brushy areas, and deserts and subsists mainly on shrubs and cacti, such as mesquite and prickly pear, but grasses and herbs are also eaten. The cottontail has a restricted home range of 1–5 acres and is normally active early in the morning and at night (Cockrum 1982:129, 133; Findley et al. 1975:87, 89; Hall and Kelson 1959:267; Schwartz and Schwartz 1981:103). A variety of methods (e.g., snares, rabbit sticks, throwing sticks, clubs, bows and arrows, nets) were used ethnographically to hunt cottontail (see Natural History and Ethnographic Background).

The black-tailed jackrabbit is most common in open, treeless habitats (Findley 1987:55) and usually feeds at night on grasses, mesquite, and herbs but also eats cultivated crops. The size of the jackrabbit home range is dependent upon the availability of food, cover, and water and varies, therefore, from 4–75 ha. Jackrabbits are more easily obtained with communal hunts and drives, using nets and clubs.

The artiodactyl indices are not surprising for the LA 34150 (Townsend Bison area) and the possible associated Townsend Area C, Late Archaic locus. The index for LA 68182 (Los Molinos) (0.57) and LA 109476 (0.56) is noteworthy, suggesting artiodactyl hunting was of primary importance for subsistence. The fairly common occurrence of leporids at LA 5148 (Laguna Plata) (0.27) and LA 66168 (Fox Place) (0.36) suggests leporids were an important component of the diet of the sites’ inhabitants. LA 120945 (Laguna Gatuna) has a very low index (0.03), indicative of a greater emphasis on the procurement of leporids, as do LA 116471 (Punto de Los Muertos) (0.11), LA 44565 (Rocky West) (0.14), and LA 34150 (Townsend Area A [0.11] and Area B [0.16]). In general, with the exception of LA 109476 (0.56), LA 68182 (Los Molinos) (0.57), and Townsend Bison area (LA 34150) (1.00), artiodactyls appear to have been hunted less frequently than lagomorphs.

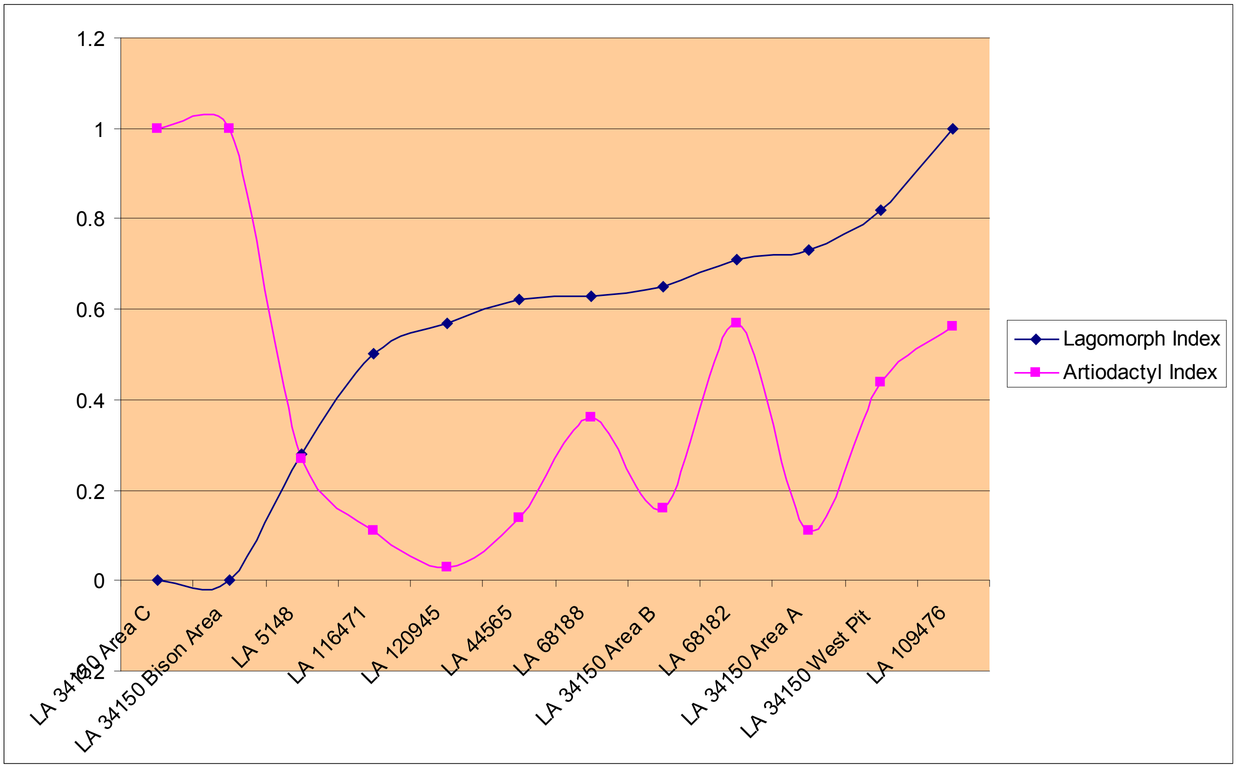

Figure 14.12 Leporid and artiodactyl indices summary graph

14.6 Conclusions

Although no economic botanical taxa were recovered from flotation or pollen samples during the present project, starch remains provide solid evidence that the ground stone tools were used for grinding grain, and the ceramic vessels were cooking implements. Maize was in use at the site as were two different grasses that are probably wild rye and possibly little barley. Organic residue analysis from a ground stone implement yielded evidence of processing agave, saltbush, cholla cactus, grass seeds, nuts, and maize. In addition, residue from a sherd is indicative of acorn, cultivated gourd, pumpkin, and/or squash, and meat, probably lagomorphs. Subsistence, therefore, was based on a combination of hunting and agriculture.

The archaeofaunal assemblage from LA 5148 consists of 1863 vertebrate faunal remains, of which 1810 were recovered during the LCAS excavations in 1970 and 53—40 from testing and 13 from off-site trenching—were found during the present project. A series of research questions were posed at the beginning of this chapter and form the basis for the following conclusions.

Was subsistence based partly on agriculture and partly on hunting and gathering or exclusively on one of the other?

The leporid index of 0.28 indicates jackrabbit was the primary small game. The artiodactyl index is 0.27, which is indicative of hunting that was more focused on the procurement of rabbits, but with artiodactyls also contributing to the diet. The most common artiodactyl is pronghorn but deer and bison are also present. Although no economic botanical taxa were recovered from flotation or pollen samples during the present project, lipid and starch studies indicate the presence of maize and other cultigens (see Appendices F and G). Subsistence, therefore, was based on hunting and agriculture.

Are local and/or long-distance hunting discernible in the faunal assemblage and what was the importance of each?

The skeletal part representation data indicate, except for deer and bison, essentially the entire leporid and artiodactyl skeletons are represented, which is indicative of local procurement. Local procurement is also indicated by the presence of four identified pronghorn butchering units that represent primary butchering debris, removal of the feet. The paucity of definite deer remains may have resulted from longer-distance hunting, suggesting the bones were subject to the “schlepp effect” (Perkins and Daly 1968), in which less desirable portions of a carcass are left at the kill site and the more valued portions are brought to the site. The presence of Laguna Plata, with its springs and seeps, suggests bison were undoubtedly attracted to the area. The paucity of bison and bison-size remains at LA 5148 itself, therefore, indicates bison were not necessarily killed at the site, but in the general vicinity. The presence of foreleg and hindleg elements suggests the distance was not unduly far. These bones are high meat value elements that also have high marrow content. The broken condition of the bones suggests processing for marrow. Overall, the faunal remains are indicative of local, probably opportunistic hunting as animals were attracted to Laguna Plata.

Leporids are r-selected species. Although they contain much less meat than artiodactyls, they are more reliable meat resources. Leporids are not as adversely affected by hunting pressures, as are artiodactyls. In addition, rabbits and other small mammals could have been easily procured by women and children as part of a garden hunting strategy by using a variety of simple techniques (e.g., traps, deadfalls, snares, rabbit sticks). In general, however, artiodactyls (especially pronghorn) were procured locally as the opportunity presented itself and the presence of low and high meat value elements suggests entire carcasses were brought to the site or, in the case of bison, were initially butchered at the nearby kill locus.

What resources were dietary staples?

The staple meat resources of the site’s occupants were leporids and artiodactyls (especially pronghorn), almost to the total exclusion of other animals, such as rodents, which may be the result of the use of ¼-inch screens during data recovery by LCAS. Ethnographic data document the use of prairie dogs, woodrats, and pocket gophers as dietary supplements by a variety of groups (see Natural History and Ethnographic Background).

What butchering patterns are discernible in the faunal assemblage?

As indicated by the skeletal part representations for leporids and artiodactyl, several general butchering patterns are discernible. In general, complete rabbit and pronghorn carcasses were brought to the site and the skull and foot elements—as indicated by the four identified pronghorn butchering units—were discarded as butchering refuse. The paucity or underrepresentation of rabbit trunk elements may have resulted from processing that differed from that of the rest of the carcass. Trunk bones may have been pulverized and consumed with the meat. The exhibited pattern, however, may have resulted from the use of ¼-inch screens. For the artiodactyls, including deer and bison, the major long bones have been broken, probably for the extraction of marrow. No complete artiodactyl long bones are present. For both leporids and artiodactyls, both low and high meat value elements, indicative of on-site butchering, processing, and consumption refuse, are present.

What was the role of bison exploitation in subsistence at the site?

Bison (n=3) and probable bison (n=8) remains were only recovered from Features 1 and 3, which are probably contemporaneous (Formative III–VI) and only three bison-size specimens were recovered from Feature 2, which dates to the Archaic IV. Feature 1 probably has the remains of at least two individuals, and Feature 3 has one. The bison-size remains from Feature 2 also represent one individual. The paucity of bison and bison-size remains, therefore, suggests hunting did not focus on the procurement of bison. Bison were probably hunted opportunistically, as they were drawn to Laguna Plata. The presence of both low and high meat value elements suggests bison were procured nearby. Bison probably supplemented the regular meat diet. The fragmentation of the bones indicates probable processing for bone marrow.

Did subsistence strategies change with the availability of Bison?

Based on the faunal assemblages from the three features, which represent two periods of occupation, subsistence strategies, in terms of animals hunted and carcass processing, do not appear to have changed. Hunting focused on the procurement of leporids and artiodactyls. No definite pronghorn or bison remains, however, only deer/pronghorn (n=3) and bison-size remains, are in the Feature 2 (Archaic IV) assemblage. Leporids are present in all three features and carcass processing is the same. Although the data are limited for artiodactyls, carcass processing apparently remained essentially the same though time. Carcasses, or portions thereof, were brought to the site and prepared for consumption and the long bones were broken for the marrow. Hunting of artiodactyls, including bison, was probably opportunistic, as the animals were attracted to Laguna Plata.

Is seasonality discernible in the faunal assemblage?

As indicated above, because of the long breeding season for leporids in southeastern New Mexico, use of ages based on long bone epiphyseal fusion rates is not a reliable method for determining seasonality. The LA 5148 leporid remains, therefore, do not lend themselves to providing reliable information concerning seasonality of site occupation. In addition, the artiodactyl remains are not appropriate for providing information about seasonality. Seasonality, therefore, is not discernible in the faunal assemblage.

What do the leporid and artiodactyl indices reflect?

The leporid index of 0.28 indicates jackrabbits predominate and the artiodactyl index of 0.27 indicates the presence of more rabbits than artiodactyls. This suggests a garden hunting strategy. The fairly common occurrence of artiodactyls at LA 5148 indicates they were an important component of the diet of the sites' inhabitants.

Is there evidence for food stress in the faunal assemblage, such as fracturing long bones for marrow extraction and pulverizing small animals for complete consumption?

All of the artiodactyl long bones have been broken, probably for the extraction of marrow. This was probably one of the main reasons for the presence of bison long bone elements in the assemblage. There is no evidence, however, for the production of bone grease. No large piles of pulverized bone were reported or recovered. Although the trunk elements of rabbits, especially cottontail, are underrepresented, essentially the entire rabbit skeleton is represented among the remains. The trunk bones may have been pulverized and consumed with the meat. This would have made consumption of the torso easier, rather than having to pick out all of the little bones. In addition, baking or boiling small animals can soften bones such as cervical and thoracic vertebrae and ribs, allowing incidental consumption with the meat. The exhibited pattern, however, may have resulted from the use of ¼-inch screens. In any case, the site occupants were probably not experiencing food stress and did not need to maximize the food value of their meat resources.

15.0 Shell Artifact Analysis

Peter C. Condon and Benjamin G. Bury

One discoidal circular-shell bead (Specimen 50), 4.5 mm in diameter with a central perforation was recovered at LA 5148 (Figure 10.36). Examination of the bead using a stereoscopic microscope, revealed the drilling for the central hole had been initiated from each surface, meeting in the middle. This technique is discernible on the interior surfaces of the central perforation. The bead was collected southeast of the C-10-C locus within a deflated basin. This discoidal bead is one of two beads recorded from LA 5148 (Laumbach et al. 1979).

Wiseman documents more than 450 shell fragments at LA 116471 (Wiseman 2003:95). In Eddy County, mollusk remains have been identified in association with features at LA 131686 and LA 131687 by Condon (2002) and at the Macho Dunes site (LA 29363) by Zamora (2000). In each case, the freshwater mollusks have been tentatively identified as *Crytonaias tampicoensis*, *Popenaias popie*, and *Lampsilis teres* (Condon 2002:159; Katz and Katz 1985:24; Wiseman 2003:95; Zamora 2003:121). In 2002, mollusk samples from LA 131686 and LA 131687, were submitted to Artie L. Metcalf, Professor Emeritus at the University of Texas at El Paso, for identification.

The specimens were identified as *Crytonaias tampicoensis*, also known by the common name of Tampico Pearlymussel (Condon 2002:160). This species of mollusk varies in color, with white with iridescence to deep purple shading a common color for living specimens (Neck and Metcalf 1988:262). This bivalve is presently common in streams of southeastern Texas and extends westward to the lowermost reaches of the Pecos River. Prehistorically, the species is frequently identified in fluvial sediments along the Pecos River in southeastern New Mexico.

Figure 15.1 Specimen 50, shell bead recovered from surface context at LA 51418 at 20x magnification

16.0 Radiocarbon Dating

Peter C. Condon

Chronology was established through relative dating of diagnostic artifacts and absolute-dating radiocarbon analysis. In particular, accelerator mass spectrometry (AMS) were conducted on three features (n=4 samples submitted), two soil horizons (n=2), two carbon lenses (n=2) in stratigraphic profiles, and one bison (*Bison bison*) bone fragment (n=1), in an attempt to establish a more refined chronometric sequence for the site and its environs. Chronometric samples were selected from charred wood post remnants from Features 2 and 3 providing the first radiocarbon dates from these two pit houses. In addition, Feature 6 yielded an AMS date by which to compare cultural contemporaneity to the two structures.

Initial calibration of radiocarbon years was conducted using the Pretoria Calibration procedure. This technique correlates tree-ring data to the mean values derived from the radiocarbon sample using a closeness-of-fit parameter for a more accurate age determination (Miller 1996:68). The radiocarbon dates were processed through the Oxford Radiocarbon Calibration Software program (OxCal) which standardized the calibration curve for all radiocarbon assays.

Nine samples were submitted for radiocarbon dating. Four samples of wood charcoal were submitted from Features 2, 3, and 6. Two sediment samples were collected from Trench 1. Two wood charcoal samples were from buried carbon lenses in Trench 8. A bison (*Bison bison*) bone fragment for collagen dating was collected from Trench 6 (Table 16.1). These samples were targeted for AMS dating to bracket the occupation episodes for LA 5148 and correlate with the relative dates of the diagnostic artifacts. Based on results of the radiocarbon data from Features 2 and 3, two potential occupation events are associated with the pit houses excavated by LCAS.

The radiocarbon sample from Feature 2 was collected from a small post remnant along the southwestern margin of the pit house (Figure 16.1). This post remnant was the only architectural element left intact from the LCAS excavations. After the LCAS excavation, Feature 2 was covered with plastic sheeting and reburied (Runyan 1971). During the current TRC testing program, this post was exposed and found to have further deteriorated. During the TRC testing,, charred wood fragments were identified in situ, collected, sealed in an aluminum foil packet, and submitted for AMS analysis. The AMS analysis yielded a conventional age of 1740±25 B.P. with a calibrated, 2-sigma age range of A.D. 230–390 (UGA 6724). This age estimate falls within Katz and Katz's (1993) Archaic IV phase. This age is in keeping with the depositional history of the northern portion of the site, which suggests the structures may predate the later Formative occupations at the site. The construction of the pit house post-dates the reddish/brown alluvium into which the structure is intrusive and predates the formation of the overlying anthrosol. No other posts remained intact within Feature 2,therefore, no additional radiocarbon samples were recovered.

Two radiocarbon samples were collected from Feature 3. Post A, an approximate 15 cm diameter charred post remnant, exposed in the northeast boundary of the pit house. This post remnant was deteriorating. Wood charcoal fragments from the post were collected and submitted for AMS analysis. The analysis yielded a conventional age of 870±28 B.P. with a calibrated, 2-sigma age range of A.D. 1040–1260 (UGA 7215). This age estimate falls within Katz and Katz's (1993) Formative III through VI phases. The difference in the two-pit house dates prompted a second radiocarbon sample collected from a second post to be submitted for analysis.

Table 16.1 Accelerator mass spectrometer data for LA 5148

Site No.	Feature No.	Lab. No.	Material	13C/12C	Conventional Age B.P.	OxCal Age Range	Cultural Affiliation
LA 5148	2	UGA-6724	Wood Charcoal	-24.9 o/oo	1740±25	A.D. 230-390	Archaic IV
LA 5148	3-Post A	UGA-7215	Wood Charcoal	-22.8 o/oo	870±28	A.D. 1040-1260	Formative III-VI
LA 5148	3-Post C	UGA-6725	Wood Charcoal	-25.7 o/oo	900±25	A.D. 1040-1220	Formative III-VI
LA 5148	6	UGA-6723	Wood Charcoal	-24.7 o/oo	1670±25	A.D. 260-430	Archaic IV
LA 5148	Trench 1-Zone 14	UGA-7210	Sediment	-23 o/oo	4690±25	3630-3370 B.C.	Na
LA 5148	Trench 1-100–105 cm	UGA-7211	Sediment	-24.30 o/oo	510±25	A.D. 1390-1450	Na
Off site	Trench 8-77 cm	UGA-7212	Charcoal	-11.60 o/oo	3660±25	2140-1950 B.C.	Na
Off site	Trench 8-60 cm	UGA-7213	Charcoal	-13.10 o/oo	3470±26	1890-1690 B.C.	Na
Off site	Trench 6	UGA-7214	Bone (Bison)	-8.90 o/oo	280±27	A.D. 1510-1800	na

Post C, also a 15 cm diameter charred post remnant was documented in the northwestern portion of the pit house. Post C is 70 cm west of Post A, along the northern margin of the structure. This post was collected, with wood charcoal submitted for AMS analysis. The analysis yielded a conventional age of 900±25 B.P. with a calibrated, 2-sigma age range of A.D. 1040–1220 (UGA 7215). The date overlaps with the age of Post A, falling within Katz and Katz's (1993) Formative III through VI phases. The radiocarbon data indicates the abandonment of Feature 3 occurred at least 750 years after the abandonment of Feature 2. While the age discrepancy is unexpected, the topographic context of the prominent knoll and reoccurring deflation and sediment aggregation, allowed this locus to have temporally different occupations occurring on the same surface (F. Nials, personal communication 2010).Feature 6, a small, steep sided pit feature identified southeast of Features 2 and 3 also contained wood charcoal from its bottom. The AMS analysis yielded a conventional age of 1670±25 B.P. with a calibrated, 2-sigma age range of A.D. 260–430 (UGA 6723). The date overlaps with the age of Feature 2, falling within Katz and Katz's (1993) Archaic IV phase. The radiocarbon data indicates the abandonment of Feature 6 is contemporaneous with the abandonment of the pit house. The dates suggest the northern portion of LA 5148 reflects at least two periods of use, both predating the development of the prominent anthrosol that blankets the northern area.

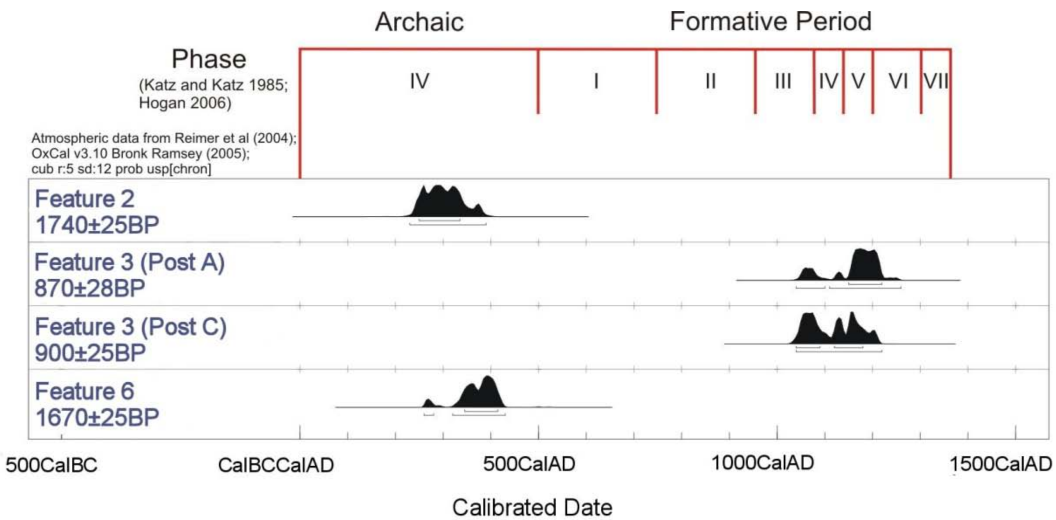

Figure 16.1 Calibration histograms for all corrected age estimates

When the chronometric data from LA 5148 are compared to comprehensive radiocarbon datasets provided by Railey, Rissetto, and Bandy (2009) then the occupation of LA 5148 occurs immediately prior to and immediately after the peak periods of occupation in the region (Figure 16.2). Assigning an arbitrary 200-year time increment, the 95 percent confidence level indicates increased occupation in the region as early as 50 B.C., peaking around A.D. 750, and declining by A.D. 1750. The cumulative-age peak, as shown by the radiocarbon age histogram, indicates a range of more intense occupation between A.D. 550 and 950. This age distribution, although differing slightly from Railey, Rissetto, and Bandy (2009:50, Figure 9.13), supports the general variation in regional occupation, including LA 5148.

The chronometric evidence, when compared to climatic data presented by Berry and Berry (1986), Grissino-Mayer et al. (1997), and Railey, Rissetto, and Bandy (2009) suggest an extended period of increased moisture from 3300/3000–300 B.C. followed by a general trend towards drier conditions (Railey, Rissetto, and Bandy (2009:54). Grissino-Mayer et al. (1997) discuss an extended period of increased aridity and decreased moisture between A.D. 950 and 1050 that affected southeastern New Mexico. Interestingly, Features 2 and 6 date before the drought and Feature 3 post-dates the 100-year drought.

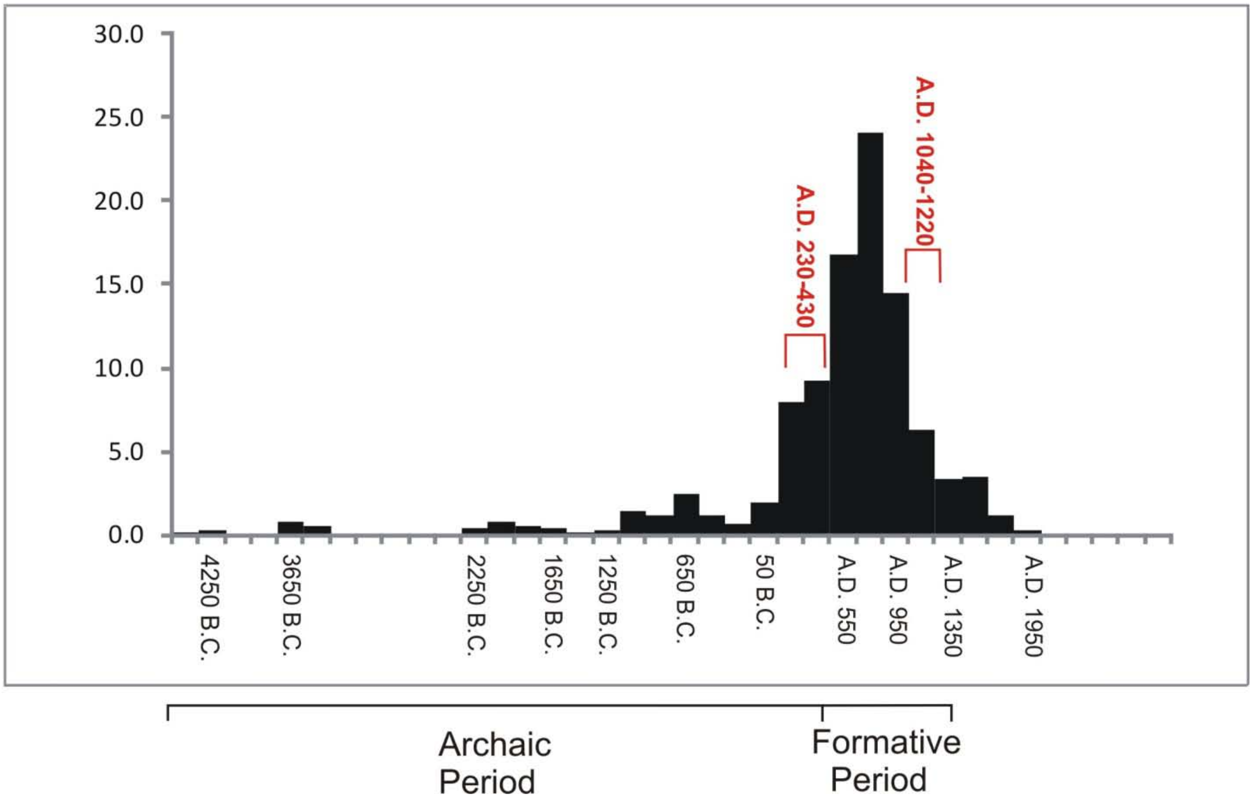

Figure 16.2 Summed probability graph for the southeastern New Mexico region (modified from Railey, Rissetto, and Bandy [2009])

17.0 25-Acre Pedestrian Survey

Peter C. Condon and Benjamin G. Bury

17.1 Introduction

Between April and May 2010, archaeologist with TRC conducted an intensive cultural resource survey of 25.0 acres subdivided into five separate parcels within the Laguna Plata Archaeological District, Lea County, New Mexico (Figure 17.1). The survey process was carried out in conjunction with the Laguna Plata testing project and aided in the documentation and assessment of the geomorphic context of the Laguna Plata site (LA 5148). All parcel locations were selected in conjunction with the project geomorphologist and the BLM-CFO lead archaeologist, George MacDonell.

Parcel 1 consists of a 5-acre block immediately north of the Laguna Plata site boundary. This area was selected due to its proximity to LA 5148, intact contextual integrity, and ability to yield information on the landform associated with the LCAS excavation of C-10-C locus. Parcels 2 and 3 consisted of two contiguous 5-acres parcels that formed a 10-acre east-west oriented rectangular. Parcel 3 overlapped LA 5148 at its west-central border. Parcels 2 and 3 provided a cross section of the landform associated with the western boundary of the site and adjoining fan topography. Parcel 4 is a 5-acre block in the southeastern margin of the Laguna Plata playa. This parcel provided a cross section of a small playa margin and adjoining terraces. Previously recorded site LA 145247 is about 100 m north of the parcel (Higgins et al. 2004). Parcel 5 is a 5-acre block about 400 m east of the Laguna Plata playa margin. This parcel included a spring vent, associated ridges, and a dune setting overlooking the Laguna Plata. Previously recorded site LA 145248 is immediately north of the parcel's north boundary (Higgins et al. 2004).

17.2 Environmental Setting

The northwestern portions of the basin are characterized by an eroded surface demarcated by red-colored paleosols (Triassic Redbeds) and lag deposits most notable in the western portions of Parcel 1 (Haskell 1977). The shoreline margin is further demarcated by linear curving terraces and small to medium sized mesquite stabilized coppice dunes. Parcels 2 and 3 are characterized by a low-lying fan in Parcel 2 and a linear ridge that encompasses a portion of LA 5148 in Parcel 3. Alluvial gravels and small knolls/terraces are identified within the northern and western parcels. These terraces are incised by west/east running arroyos emanating from the upper rim of the basin and emptying into the playa proper.

The environmental setting for Parcels 4 and 5 are markedly different. Stabilized dunes border small, spring fed playas, and deeply incised channels in the southeastern margin of the Laguna Plata basin. An eroded dune field also marks the terrain south and east of the basin, with a mixture of exposed paleosol and aeolian deposition characterizing this area. Topography associated with the playas tends to be open with ongoing sedimentation in the playa proper, and overgrown with vegetation along the margins and channel margins. Parcels 4 and 5 are associated with this environmental setting.

17.3 Site Records Search

Prior to the initiation of fieldwork, the site files of the Archaeological Records Management Section (ARMS) were queried. The ARMS system maintains an online database of all recorded archaeological and historic sites within the state of New Mexico. Printed copies of all available New Mexico state site forms were produced from the ARMS file search. A search of the National Register for Historic Places (NRHP) online information system was done to determine if any sites within the project area besides LA 5148 are listed on the NRHP.

This page has been removed to protect confidential site location information.

Peter C. Condon conducted the file searches, prior to fieldwork. The purpose was to determine if any cultural resources had been previously documented in the project area. Twenty-three previously recorded sites were identified within one half mile (0.8 km)of LA 5148 and the five survey parcels (Table 17.1). Most of these previously documented sites occur within the Laguna Plata Archaeological District. In each case, the sites are d outside of the LA 5148 boundary and five blocks.

17.4 Field Methods

The five surveyed parcels were inventoried by means of a 100 percent pedestrian survey. Peter C. Condon, Ben G. Bury, Jesse Clark, and Javi Vasquez conducted the survey. Light and weather conditions during the survey were favorable. Vegetation was sparse and surface visibility was estimated at least 99 percent in Parcels 1 through 3, while portions of Parcels 4 and 5 were overgrown with vegetation with visibility less than 25 percent.

The field crew performed a Class III pedestrian survey within each parcel as designated within the scope of work under Task Order 05 by the BLM-CFO. TRC conducted the survey by means of linear transects initiating on the north and south margins of each parcel. Linear transects were spaced 10 m (32.18 ft) apart with artifact encountered marked with pin flags. This method of survey was intended to most effectively identify and record all cultural resources within each block. Cultural resources encountered during the pedestrian survey were recorded and all artifacts were analyzed in the field.

The survey method employed by TRC used customized ArcView script programs. GPS units (Trimble GeoXTs running ArcPad software) were used to link the survey data with relevant support data sets-electronic versions of field aerials and topographic maps, project boundaries, road maps, and soil and vegetation maps to facilitate fieldwork.

Supplemental recordings of artifact inventories and attributes were done using PDA units with ArcPad GIS software and Bluetooth-enabled GPS receivers. The GPS unit and PDA were provided to all crewmembers with an on-screen aerial view of the TRU grid system and the existing site polygon. Field evaluations confirmed the existing site-polygon file of the five parcels. Customized data-collection software provide rapid post-field processing of the results. The system provided input fields for recording information such as cell provenience data, flaked-stone debitage, ground stone, ceramics, other artifacts, and feature details from a single screen. All GPS collected data was recorded in NAD 83 and an associated GIS layer was created using ArcMap software.

As defined by the New Mexico BLM (2005:I-9–I-10), a site is a locus of past human activities or events, extremely variable in size, ranging from a cluster of several objects or materials to structures with associated objects or features. A site may consist of secondarily deposited cultural resource remains. A variety of features—hearths, cairns, rock alignments, masonry concentrations, burned adobe, fire-cracked rock, cisterns, corrals, and rock art—are generally recorded as sites. In addition, definite loci of traditional cultural or religious importance to specified social and/or cultural groups are considered sites. The New Mexico BLM recognizes three types of cultural resources—Category 1 sites, Category 2 sites, and isolated manifestations. The designation of a cultural resource as one of these types necessarily involves a consideration of NRHP eligibility and whether or not field recordation to current professional standards can result in the preservation of the resource's information content in an archival form.

An electronic review of site records maintained by the Archaeological Records Management Section (ARMS) of the Museum of New Mexico in Santa Fe on February 5, 2010 and at the BLM Carlsbad Field Office identified 24 previously recorded sites within 0.8 km (0.5 mi) of LA 5148 and the five survey parcels. LA 5148 is within Survey Parcels 1–3. None of the other sites are within the five survey parcels. The ARMS and BLM records searches also identified four previous surveys with no recorded sites within

0.5 km (0.3 mi) of the five survey parcels. Peter Condon completed a site record check of the BLM Carlsbad Field Office on April 5, 2010.

Table 17.1 Previously recorded sites within 0.8 km (0.5 mi) of the survey parcels

LA Site Number	Other Site Designations	NMCRIS No.	Site Size (m2)	Temporal Range	NRHP Recom-mendation
5148	FRA-61, FRA-60, NM-06-2500, NM-06-0113, AR-30-6-113, NMSU553, LP-1, LCAS C-10-C, HPD 1520	393, 116112, 116958	81,250	2740–1520 B.C., A.D. 210–280, A.D. 1050–1440	Eligible
22098	NM-06-2501, NMSU 554, LP-02, HPD 1520	393	3,000	A.D. 750-1100; A.D. 1100–1400, 9500 B.C.–A.D. 1993	Eligible
22099	NM-06-2502, NMSU 555, LP-03, HPD 1520	393	3,000	A.D. 750–1100, A.D. 1100–1400, 9500 B.C.–A.D. 1993	Eligible
22100	NM-06-2503, NM-06-0114, NM-06-0107, NMSU 556, LP-4, HPD-1520	393	30,000	A.D. 750–1100, A.D. 1100–1400, 9500 B.C.–A.D. 1993	Eligible
22101	NM-06-0622, NM-06-0117, NMSU 557, LP-05, HPR-1520	393	30,000	A.D. 1100–1400, 9500 B.C.–A.D. 1993	Eligible
22102	NM-06-0623, NMSU 558, LP-06,ENM 10018, HPD 1520	31565, 116958	30,000	A.D. 100–1400, 9500 B.C.–A.D. 1993	Eligible
22103	NMSU 559, LP-07, HPD 1520, NM-06-2506	393	2,100	A.D. 750–1100	Eligible
22104	NM-06-0623, AR-30-6-623, NMSU 560, LP-08, ENM 10019, HPD 1520	393	30,000	A.D. 750–1100, A.D. 1100–1400, 9500 B.C.–A.D. 1993	Eligible
22105	NMSU 561, LP-09, HPD 1520	393	30,000	A.D. 1100–1400	Eligible
22106	NM-06-0624, AR-30-6-624, NMSU 562, LP-10, ENM 10019, HPD 1520	393, 31565	3,000	A.D. 750–1100, A.D. 1100–1400, 9500 B.C.–A.D. 1993	Eligible
22107	NMSU 563, LP-11, ENM 10668, HPD 1520, LA 22115, LA 22116	393	999,999	A.D. 500 to 1100, A.D. 1100–1300, A.D. 1350–1880	Eligible
22108	NMSU 564, LP-12, HPD 1520	393	7,500	9500 B.C.–A.D. 1993	Eligible
22109	NM-06-2512, AR-30-6-2512	393	30,000	9500 B.C.–A.D. 1993	Eligible
22110	NMSU 566, LP-14, HPD 1520	393	30,000	9500 B.C.–A.D. 1993	Eligible
22112	NM-06-2515, PAC/LE-117, NMSU 568, LP-16, HPR 1520, LA 22121, LA 22122, LA 47384	393, 49377, 2062, 89953, 100842, 32901	Unknown	100–500 A.D., 1050–1400 A.D., 1800 B.C.–A.D. 500	Eligible
22113	NMSU 569, LP-17, HPD 1520	393	Unknown	A.D. 750–1100, A.D. 1100–1400, 9500 B.C.–A.D. 1993	Eligible
22114	NMSU 570, LP-18, HPD 1520	393	30,000	9500 B.C.–A.D. 1993	Eligible
22121	NMSU 577, NM-06-0503, PAC/LE-117	2795, 89953	7,500	9500 B.C.–A.D. 1993	Eligible

LA Site Number	Other Site Designations	NMCRIS No.	Site Size (m2)	Temporal Range	NRHP Recom-mendation
22122	NMSU 578, LP-26, HPD 1520, LA 22112	89953	7,406	9000–8000 B.C.	Eligible
47384	NMAS 5637, HPD 1520, LA 22112	393	30,000	A.D. 1175–1400	Eligible
145246	RH-1	89953	6,400	A.D. 200–1400	Eligible
145247	RH-2	89953	1,130	9500 B.C.–A.D. 1880	Eligible
145248	RH-3	89953	2,583	9500 B.C.–A.D. 1880	Eligible
145249	RH-4	89953	1,9271	9500 B.C.–A.D. 1880	Eligible

Table 17.2 Previous surveys with no recorded sites within 0.8 km (0.5 mi) of the survey parcel

NMCRIS	Reference	NMCRIS	Reference
1517	Maclennan 1980	23997	Haskell 1987
106749	Pangburn and Youngberg 2007	116112	Runyan 1972

An examination of the current listings of the National Register of Historic Places (NRHP) and State Register of Cultural Properties (SRCP) indicated LA 5148 is listed on the State Register and the National Register as a contributing element of the Laguna Plata Archaeological District Thematic Group (SR 1520, NR 89001209).

Category 1 sites (1) contain less than 15 artifacts; and/or (2) have few features; and/or (3) are surface scatters; and (4) may have soil stains, but without associated features or artifacts. These sites have little or no depth and do not contain dateable hearths, hearths with significant ethnobotanical or ethnozoological remains, prehistoric architectural features, or shrines. In addition, they do not relate to other nearby Category 1 sites. The significance of a Category 1 site lies solely in its ability to yield information under NRHP Criterion D, information potential. The field recording of essential basic data, however, can exhaust the information potential of these sites (New Mexico BLM:2005:I-10).

Category 2 sites are sites that do not fit the criteria for Category 1 sites or isolated manifestations. Although field recordation to current professional standards usually is usually not sufficient to preserve the information content of Category 2 sites, these sites are not necessarily eligible for nomination to the NRHP (New Mexico BLM:2005:I-10). Although no new sites were recorded, each new site would have had a datum, consisting of a rebar and aluminum cap with “TRC Do Not Disturb” and stamped with a field site number, placed within its boundary.

An isolated manifestation (or IO) consists of fewer than 10 artifacts or a single, undateable feature. Frequently, isolated manifestations are redeposited materials lacking significant locational context. They are not related to other nearby isolated manifestations or sites (New Mexico BLM:2005:I-10).

17.5 Survey Results

Data collected during the survey complimented the testing program and provided for possible expansion of the LA 5148 boundary. This is particularly relevant for Parcel 1 and combined Parcels 2 and 3. Parcel 1 was a 150 x 150 m block placed immediately north of LA 5148. This locus was selected to compliment the geoarchaeology identified in trench profiles within to this parcel and to evaluate the spatial distribution of cultural material north of the site.

17.5.1 Parcel 1

Parcel 1 was placed just outside the northeast boundary of LA 5148. The survey block encompassed margins of deflated, level alluvial fans and undulating mesquite stabilized coppice dunes. As Figure 17.2 illustrates, the central portion of the parcel was flat grasslands. The small portion of the western edge captured the eastern slope of a small knoll similar in form to the C-10-C locus. The eastern half of Parcel 1 was characterized by active and eroded dune fields that served as a barrier to the playa margin. As shown in Figure 17.2, the spatial distribution of artifacts should be considered an extension of LA 5148. Artifacts beyond the Parcel 1 boundary connect LA 5148 with the outer artifact scatters. Artifacts documented west of the dune field were not in context and were considered lag deposits. Artifacts identified within the dune field were also out of context, however, the dune fields blanketed intact cultural deposits, and therefore, these artifacts served as a guider for future archaeological investigation. Table17.2 summarizes data for artifacts recorded within Parcel 1.

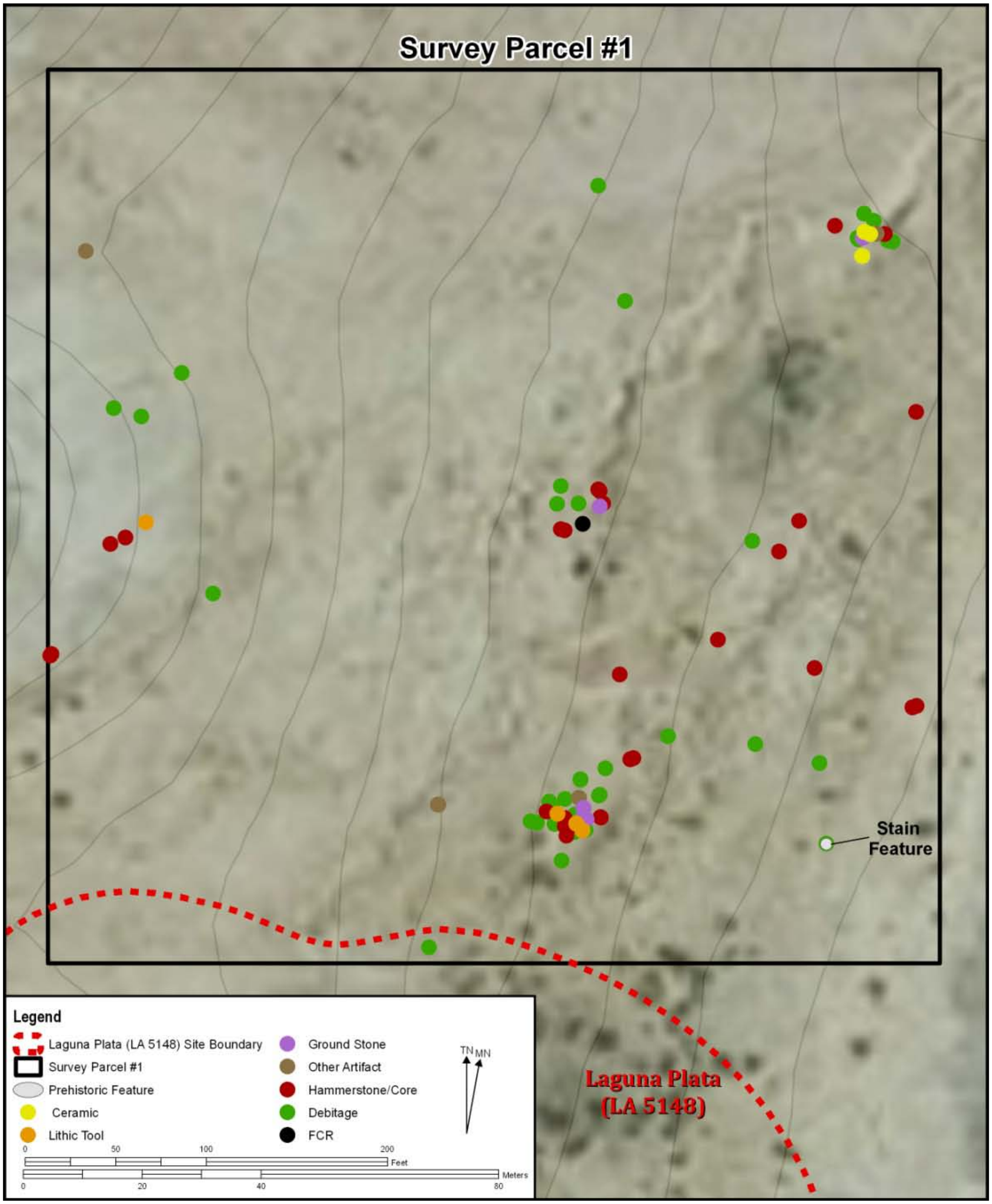

Figure 17.2 Artifact distribution within Parcel 1

Table 17.3 Artifact summary data for Parcel 1 (n=136)

Artifact Type	Artifact Count (n=)	Frequency (%)
Lithic Debitage	65	49.61
Utilized Debitage	5	3.81
Core/Core Fragment	20	15.26
Tested Cobble	2	1.52
Hammerstone	8	6.10
Flaked-Stone Tools	4	3.05
Ground Stone	5	3.81
Ceramics	3	2.29
Other Artifacts	19	15.50

Parcel 1 contained 136 artifacts, including lithic debitage (n=70), flaked-stone tools (n=4), hammerstones (n=8), cores (n=20), tested cobbles (n=2), ground stone implements (n=5), and pottery (n=3). In addition, faunal, shell, and burned-caliche cobbles were also documented (n=19). One feature was documented in the southeast corner of the parcel. This small carbon-stained feature was identified eroding out of a west facing dune and attests to the potential for buried cultural deposits immediately north of LA 5148. Loose associated scatters of artifacts were noted along the west/central edge of the block, with small concentrations of artifacts observed along the dune margins. All artifacts were assigned a provenience point, mapped, and recorded. Results of the survey are presented below.

17.5.2 Lithic Debitage

Parcel 1 contained 70 pieces of lithic debitage. This assemblage consisted of utilized debitage (n=5), flake fragments (n=14), angular debitage (n=20), and complete flakes (n=31). Four raw material types are represented by the debitage. Categories for in-field analysis included artifact type, material type, dorsal cortex, size, and modification.

The most frequent raw material was quartzite (58.57 percent/n=41), then chert (38.57 percent/n=27), limestone (1.42 percent/n=1), and rhyolite (1.42 percent /n=1). Five very small flakes, tentatively classified as biface thinning flakes, were included in the assemblage. One was white chert, while the remaining four were homogenous gray chert. Twenty-six additional flakes were also documented. Of the 26 flakes, one (3.84 percent) was limestone, five (19.23 percent) were chert, and 20 (76.92 percent) were quartzite. A similar pattern occurs for angular debitage and flake fragments. Of the 34 pieces recorded, one (2.94 percent) was identified as rhyolite, 15 (44.11 percent) were chert, and 18 (52.94 percent) were quartzite. Utilized flakes (n=5), which numbered five in total, were comprised of two (40 percent) chert and three (60 percent) quartzite specimens.

Dorsal cortex was recorded for all complete flakes (n=31). Eleven (35.48 percent) were retained no dorsal cortex. Thirteen (41.93 percent) exhibited between 0 and 49.99 percent, while the remaining seven (22.58) had between 50 and 100 percent dorsal cortex. Maximum length was also recorded for these unbroken pieces. Debitage size was measured through a series of size categories that included Class 1 (0–0.99 cm), Class 2 (1.0–2.99 cm), Class 3 (3.0–5.99 cm), Class 4 (6.0–8.99 cm), and Class 5 (9.0–11.99 cm). These values were then used to formulate inferences on the technological organization of lithic reduction. Expedient tool manufacture, which generally limits the degree of edge rejuvenation to larger flakes, should fall primarily in the larger size classes. In contrast, biface reduction should produce small flakes that will be reflected predominantly in Class 1.

The majority, or 58.06 percent (n=18), of the flakes measured between 1.0 cm and 2.99 cm in size. Nine (29.03 percent) measured between 3.0 cm and 5.99 cm, or Class 3 category. Two (6.45 percent) measured less than 0.99 cm, or a Class 1 category. Two measured between 6.0 cm and 11.99 cm in size, or Class 4 category. Using the predominant size categories, Class 2 and 3, as a proxy measure for cobble size, we see a general small-to-medium sized morphology. This is in keeping with the size of the raw materials available across the western margins of the Laguna Plata basin.

Utilized flakes encompass a large category of tools consisting of any piece of lithic debitage that exhibits modification along one or more margins. This modification usually takes the form of noncontiguous flake removals along a single margin. Evidence for shaping the tool or rejuvenation along the cutting edge is usually absent. Modification usually occurs along a single lateral margin and along a single face. Five pieces of debitage were utilized or exhibited possible modification along one or more margins. The extent of modification was limited to inconsistent flake scars along the margins with little or no retouch or noticeable on the tool.

17.5.2.1 Cores/Tested Cobbles

Twenty cores or core fragments were documented during the Parcel 1 survey. Cores were defined as a nuclei from which flakes of varying sizes have been removed (Crabtree 1982). However, cores solely used as a source for flakes or bifaces, and cores that may have been used as tools, are difficult to differentiate. For this study, artifacts were designated as cores if they were not flakes and exhibited multiple negative flake scars along one or more surfaces.

Lithic materials are preferentially represented by quartzite (45.0 percent/n=9), followed by chert (35.0 percent/n=7), and chalcedony (20.0 percent/n=1). The strong presence of quartzite and chert in the core assemblage is noted, which follows the frequency patterns observed in the documented debitage. The majority of the core assemblage occurs in cobble form and often retains cortex (92.85 percent/n=13). Of the 14 whole cores, one (7.15 percent) exhibited no cortex, five (35.71 percent) retained less than 50 percent cortex, while eight (57.14 percent) exhibited surfaces with greater than 50 percent cortex.

Maximum length was also recorded for the complete cores. Core size was measured through a series of size categories that included Class 1 (0–0.99 cm), Class 2 (1.0–2.99 cm), Class 3 (3.0–5.99 cm), Class 4 (6.0–8.99 cm), and Class 5 (9.0–11.99 cm). Of the 14 cores, one (7.14 percent) measured less than 3.0 cm in maximum length, six measured between 6.0 cm and 11.99 cm in length, and seven measured between 3.0 cm and 5.99 cm in maximum length. Again, core size parallels the debitage finding, suggesting that available raw material was relative small in size. Two tested cobbles, one limestone and one quartzite, were recorded in Parcel 1. Each of the tested cobbles exhibited three or less three flake scars, measured between 3.0 cm and 6.0 cm in size, with cortex present on the objective piece.

17.5.2.2 Hammerstones

Eight hammerstones were documented in Parcel 1. All hammerstones were categorized by shape and material, as well as size category. Three material types were identified within the hammerstone assemblage; all eight were of coarse-grained quartzite (100.0 percent/n=8). All eight hammerstones were rounded or spherical in morphology. Hammerstone size was measured through a series of size categories that included Class 1 (0–0.99 cm), Class 2 (1.0–2.99 cm), Class 3 (3.0–5.99 cm), Class 4 (6.0–8.99 cm), and Class 5 (9.0–11.99 cm). Of the eight hammerstones, five (62.50 percent) measured between 3.0 cm and 5.99 cm, while the remaining three (37.50 percent) hammerstones measured between 6.0 cm and 11.99 cm in size.

17.5.2.3 Flaked-Stone Tools

Nonformal tools encompassed a broad range of artifact types that generally did not include hafting elements or tools created for longevity. Nonformal tools were considered task-specific and of short-term use, implying that these tool types were often manufactured, utilized, and discarded at the point at which they were recovered. Four flaked-stone tools were recorded during the Parcel 1 survey. Of the four tools, 75.0 percent (n=3) were made from quartzite and 25.0 percent (n=1) from chert. Three of the four were characterized as unimarginal, with modification observed on a single lateral margin. Two of the unimarginal tools were quartzite and one was made from chert. Modification consisted of contiguous retouch flakes along a single face and single margin. Each unimarginal tool measured between 3.0 and 6.0 cm in maximum length. The remaining tool was recorded as a quartzite core/chopper. This multifunctional tool exhibited a irregular, bifacial edge along a single margin. The remaining portions of the tool were unmodified and retained their cobble morphology. This core/chopper measured between 6.0 cm and 12.0 cm in maximum dimension.

17.5.2.4 Ground Stone Artifacts

Artifacts identified as grinding implements were classified into three tool types for the survey process. Metates and grinding slabs are usually associated with processing organic and/or inorganic materials. Manos are described as the hand implement used on the stationary metate. There are several types of manos, and they can be identified as a one-hand or two-hand grinding tool. Their shape attributes are along the edges and will have use-wear ground or a polished surface(s). Indeterminate ground stone fragment included all ground stone fragments that could not be placed into one of the other two categories.

Five ground stone artifacts were documented during the Parcel 1 survey. These five artifacts included one unbroken quartzite mano and four indeterminate sandstone ground stone fragments. Two (50.0 percent) of the four sandstone fragments were also used as fire-cracked rock and exhibited evidence for thermal alteration, including discoloration. The mano exhibited a single modified surface and measured between 6.0 cm and 12.0 cm in maximum length.

17.5.2.5 Ceramic Assemblage

The ceramic assemblage recorded within Parcel 1 consisted of only three sherds. One Chupadero Black-on-white body sherd, which dates between A.D. 1100 and 1300, one Corona Corrugated body sherd, which dates between A.D. 1225–1460, and a single Jornada Brown rim sherd. The Jornada Brown rim sherd exhibited a pinched rim and dates between A.D. 200/400–1250/1450 (Wiseman 2002, 2003). The range of ceramic type encountered during the Parcel 1 survey is similar to the previously recorded ceramic assemblage from the C-10-C locale.

17.5.2.6 Artifacts-Other

Nineteen artifacts were classified as other in the survey recording program script. These included faunal remains, consisting of a three small (<3.0 cm in length) indeterminate bone fragments, a small (<2.0 cm in length) mollusk shell fragment, and 15 burned-caliche cobbles (<12.0 cm in length). The burned-caliche cobbles were identified in the central portion of the parcel block, and in the south-central north of the Laguna Plata site (LA 5148) boundary. These two location are also along the margin of the mesquite-stabilized coppice dune field, suggesting that the burned rock may be associated with buried cultural deposits.

17.5.2.7 Features

One small carbon-stained feature was documented in the southeastern portion of the survey parcel. This feature measured approximately 1.0-m in diameter and did not any associated burned-caliche cobbles. Emerging out from the base of a west-facing dune, this feature appeared to be intrusive into the underlying paleosol. Two trowel tests into this feature attested to a depth of at least 0.10 m below ground surface.

17.5.3 Parcel 2

Parcel 2 was placed just outside the west/central boundary of the Laguna Plata Site (LA 5148). The survey block encompassed the margins of basin alluvial fans and areas of fan coalescence. The topography within Parcel 2 sloped slightly to the east, but was relatively flat with grassland and small dune development comprising the majority of the vegetation. As Figure 10.3 illustrates, this parcel terminates just west of the Laguna Plata site (LA 5148) boundary.

The spatial distribution of artifacts should be considered an extension of the Laguna Plata site (LA 5148) proper. An evaluation of these artifacts suggests that cultural materials may not be in context. Artifact displacement from areas of higher elevation, such as the ridge at the Laguna Plata site (LA 5148), or even LA 22101, a large site on the crest of the basin escarpment may be the likely origin for these artifacts. Artifacts within Parcel 2 are spatially connected to LA 5148 proper and should be included in the site context. Table 17.3 provided the summary data for artifacts recorded during the survey of Parcel 2.

Table 17.4 Artifact summary data for Parcel 2 (n=48)

Artifact Type	Artifact Count (n=)	Frequency (%)
Lithic Debitage	23	47.94
Utilized Debitage	2	4.16
Core/Core Fragment	8	16.66
Tested Cobble	4	8.33
Hammerstone	4	8.33
Ground stone Artifact	2	4.16
Ceramics	3	6.25
Other Artifacts (Historic)	2	4.16

Forty-eight artifacts, including lithic debitage (n=23), utilized debitage (n=2), hammerstone (n=4), cores and core fragments (n=8), ground stone implements (n=2), and pottery (n=3) were recorded within the 150.0-m by 150.0-m survey parcel. In addition, two small pieces of indeterminate metal and one burned-caliche cobble were also documented during the survey. Loose associated scatters of artifacts were noted along the central portion of the block, with small scatters of artifacts observed along west and far southeast sections of the parcel. All artifacts encountered were provided a provenience point, mapped, and recorded. The results of the survey are presented below.

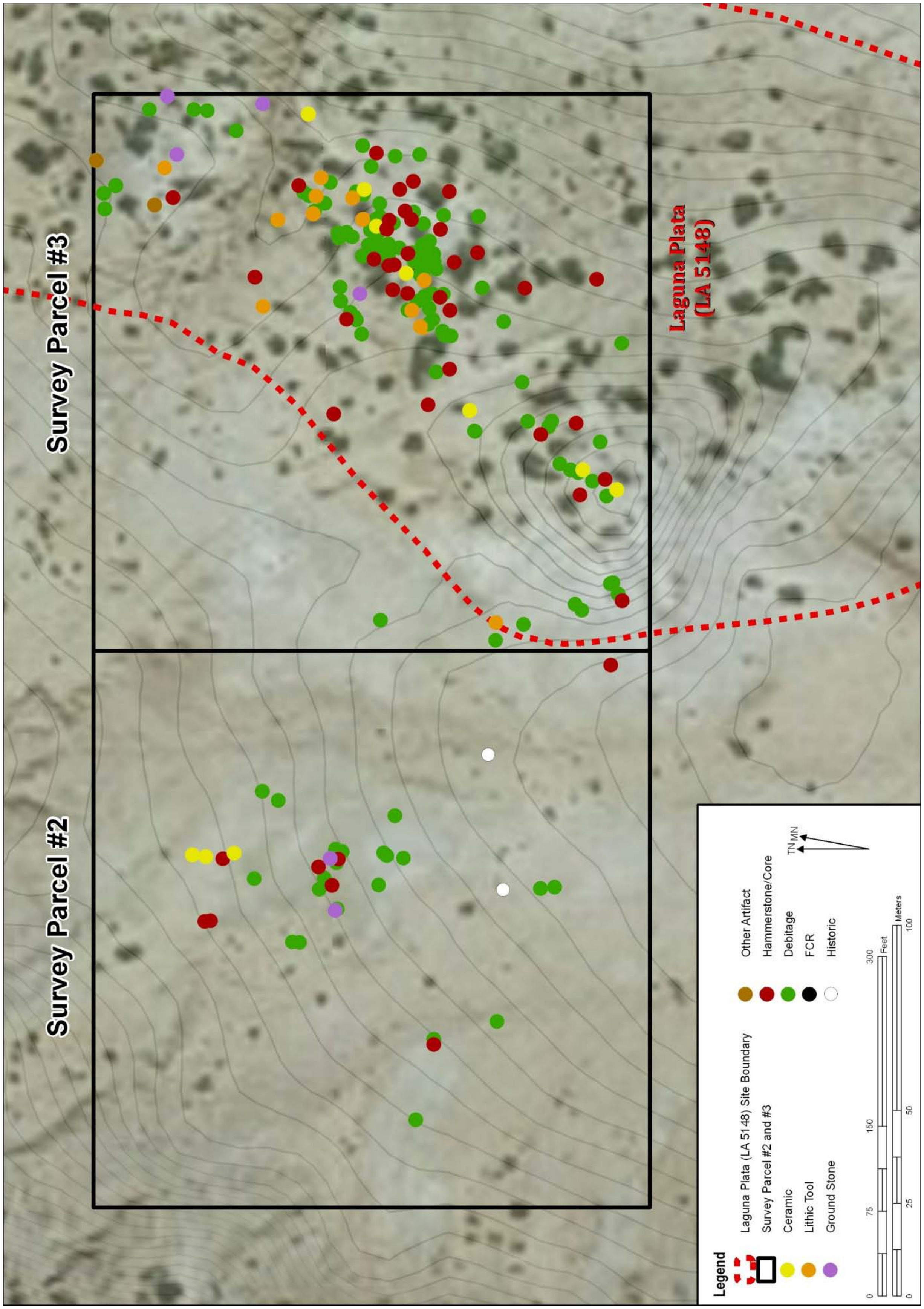

Figure 17.3 **Artifact distribution between Parcel 3 and Parcel 4**

17.5.3.1 Lithic Debitage

Twenty-three pieces of lithic debitage were documented in Parcel 2. This assemblage consisted of unbroken flakes (n=17), flake fragments (n=3), and angular debitage (n=3). In addition, two pieces of utilized debitage were also documented in this parcel, bringing the total number of debitage related artifacts to twenty-five. Categories for in-field analysis included artifact type, material type, dorsal cortex, size, and modification type.

For unmodified lithic debitage (n=23), the most frequently encountered raw material was quartzite (60.86 percent/n=14), then chert (21.73 percent/n=5), followed by rhyolite (8.69 percent/n=2), limestone (4.34 percent/n=1), and siltstone (4.34 percent/n=1). Chert coloration ranged from off white, homogenous black, and mottled orange.

Seventeen complete flakes warranted additional analysis. Dorsal cortex was recorded for all complete flakes (n=17). Four (23.52 percent) retained no dorsal cortex. Six (35.29 percent) exhibited between 0 and 49.99 percent, while the remaining seven (41.17 percent) had between 50 and 100 percent dorsal cortex. Maximum length was also recorded for these unbroken pieces. Debitage size was measured through a series of size categories that included Class 1 (0–0.99 cm), Class 2 (1.0–2.99 cm), Class 3 (3.0–5.99 cm), Class 4 (6.0–8.99 cm), and Class 5 (9.0–11.99 cm). These values were then used to formulate inferences on the technological organization of lithic reduction. Expedient tool manufacture, which generally limits the degree of edge rejuvenation to larger flakes, should fall primarily in the larger size classes. In contrast, biface reduction should produce small flakes that will be reflected predominantly in Class 1. The majority, or 76.47 percent (n=13), of the flakes measured between 3.0 cm and 5.99 cm in size. The remaining four (23.52 percent) measured between 1.0 cm and 2.99 cm, or Class 3 category. Using size categories, Class 2 and 3, as a proxy measure for cobble size, we see a general small-to-medium sized morphology, which parallel our findings in Parcel 1.

Two pieces of angular shatter were utilized or exhibited possible modification along one or more margins. The extent of modification was limited to inconsistent flake scars along the margins with little or no retouch or noticeable on the tool. The raw materials noted for these the utilized debitage pieces were black chert and purple quartzite.

17.5.3.2 Cores/Tested Cobbles

Twenty cores or core fragments were documented during the Parcel 2 survey. Cores were defined as a nuclei from which flakes of varying sizes have been removed (Crabtree 1982). However, cores solely used as a source for flakes or bifaces, and cores that may have been used as tools, are difficult to differentiate. For this study, artifacts were designated as cores if they were not flakes and exhibited multiple negative flake scars along one or more surfaces.

Lithic materials are equally represented by quartzite (50.0 percent/n=6) and chert (50.0 percent/n=6). The strong presence of quartzite and chert in the core assemblage is noted, which follows the frequency patterns observed in the documented debitage in both Parcel 1 and Parcel 2. The majority of the complete core assemblage (n=6) occurred in cobble form, the majority of which did not retain cortex (66.66 percent/n=4). Of the six complete cores, two (33.33 percent) exhibited surfaces with greater than 50 percent cortex.

Maximum length was also recorded for the complete cores. Core size was measured through a series of size categories previously presented. All six cores measured between 3.0 cm and 5.99 cm in length. Again, core size parallels the debitage finding, suggesting that available raw material was relative small in size. Four tested cobbles, all quartzite, were recorded in Parcel 2. Each of the tested cobbles exhibited three or less three flake scars, two measured between 3.0 cm and 6.0 cm in size and two measured between 6.0 cm and 12.0 cm in size. Cortex percentage was between 50 and 100 percent on all four tested cobbles.

17.5.3.3 Hammerstones

Four hammerstones were documented in Parcel 2. All hammerstones were categorized by shape and material, as well as size category. Two material types were identified within the hammerstone assemblage; two were of coarse-grained purple quartzite (50.0 percent/n=2) and two were of a black rhyolite (50.0 percent/n=2). All four hammerstones were rounded or spherical in morphology. Hammerstone size was measured through a series of size categories, presented under Parcel 1. All four hammerstones measured between 6.0 cm and 11.99 cm in size.

17.5.3.4 Ground Stone Artifacts

Artifacts identified as grinding implements were classified into three tool types for the survey process: metates, manos, and indeterminate ground stone. Two ground stone artifacts were documented during the Parcel 2 survey. These artifacts were classified as indeterminate sandstone fragments. Material type for these two ground stone fragments were basalt and sandstone. No evidence for thermal alteration, such as discoloration, was noted. The fragments measured between 6.0 cm and 12.0 cm in maximum length.

17.5.3.5 Ceramic Assemblage

The ceramic assemblage recorded within Parcel 2 consisted of only three body sherds, all typed s Chupadero Black-on-white. Chupadero Black-on-white pottery dates between A.D. 1100 and 1300 (Wiseman 2002, 2003).

17.5.3.6 Artifacts-Other

Two artifacts were classified as other-historic in the survey recording program script. These included two small indeterminate metal fragments (<3.0 cm in length). In addition, one burned-caliche cobble was identified in the central portion of the parcel block intermingled with the main cluster of artifacts.

17.5.4 Parcel 3

Parcel 3 was placed adjacent to and encompassing a portion of west/central Laguna Plata Site (LA 5148). The survey block encompassed the margins of basin alluvial fans and areas of fan coalescence, as well as a small knoll and ridge of the LA 5148 proper. The topography within the northwest portion of Parcel 2 sloped slightly to the east, but was relatively flat with grassland and small dune development comprising the majority of the vegetation. The remaining portions of the

parcel were elevated, differentially deflated, with small mesquite stabilized coppice dunes present in the intermediate areas (see Figure 3). Parcel 3 was positioned and surveyed prior to implementing a mechanical trenching strategy. Trenching initiated within the Laguna Plata site (LA 5148) and extended beyond the western boundary.

One-hundred ninety three artifacts, including lithic debitage (n=109), utilized debitage (n=1), flaked-stone tools (n=15), hammerstones (n=3), cores and core fragments (n=25), tested cobbles (n=7), ground stone implements (n=27), and pottery (n=7) were recorded within the 150.0-m by 150.0-m survey parcel (Table 17.4). In addition, two small pieces of bone and four pieces of indeterminate shell were also documented, resulting in 200 items mapped. A closer examination of the spatial distribution of artifacts within Parcel 3 shows a near absence of artifacts in the northwest quadrant. In contrast, artifact clusters are noted in the southwest corner centered on a isolated knoll and in the east/central portion of the parcel, also centered on an elevated ridge. Artifact aggregation within the Laguna Plata site (LA 5148) possibly suggests localized activity augments existing survey data from the Laguna Plata site (LA 5148) proper.

17.5.4.1 Lithic Debitage

One-hundred nine pieces of lithic debitage were documented in Parcel 3. This assemblage consisted of unbroken flakes (n=72), flake fragments (n=16), and angular debitage (n=21). In addition, one piece of utilized debitage was also documented in this parcel, bringing the total number of debitage related artifacts to 110. Categories for in-field analysis included artifact type, material type, dorsal cortex, size, and modification type.

Table 17.5 Artifact summary data for Parcel 3 (n=200)

Artifact Type	Artifact Count (n=)	Frequency (%)
Lithic Debitage	109	54.50
Utilized Debitage	1	0.50
Flaked-Stone Tool	15	7.50
Core/Core Fragment	25	12.50
Tested Cobble	7	3.50
Hammerstone	3	1.50
Ground stone Artifact	27	13.50
Ceramics	7	3.50
Other Artifacts	6	3.00

For unmodified lithic debitage (n=109), the most frequently encountered raw material was quartzite (45.87 percent/n=50), then chert (36.69 percent/n=40), followed by obsidian (7.33 percent/n=8). Occurring with less frequency were rhyolite (2.75 percent/n=3), basalt (2.75 percent/n=3), limestone (1.84 percent/n=2), sandstone (1.84 percent/n=2), and siltstone (0.917 percent/n=1).

Seventy-two complete flakes warranted additional analysis. Dorsal cortex was recorded for all complete flakes (n=72). Forty-four (61.11 percent) retained no dorsal cortex. Twenty-three (31.94 percent) exhibited between 0 and 49.99 percent, while the remaining five (6.94 percent) had between 50 and 100 percent dorsal cortex. Maximum length was also recorded for these unbroken pieces. Flake size (n=72) was measured through a series of size categories that included Class 1 (0–0.99 cm), Class 2 (1.0–2.99 cm), Class 3 (3.0–5.99 cm), Class 4 (6.0–8.99 cm), and Class 5 (9.0–11.99 cm). Forty-five (62.50 percent) flakes measured between 3.0 cm and 5.99 cm in size. This size range is consistent with date derived from Parcels 2 and 3. Class 1 and Class 3, individually represented 16.66 percent with 12 flakes each. The largest size class, Class 4 contained three flakes (4.16 percent) that measured between 6.0 cm and 12.0 cm in maximum dimension. Again size patterns parallel previous measurement ranges from Parcel 1 and 2.

A single piece of angular shatter exhibited evidence of modification along one margin. This utilized debitage measured between 3.0 cm and 5.99 cm in size and was made from a reddish colored rhyolite. Cortex percentage ranged between 50 and 100 percent on the dorsal surface.

17.5.4.2 Flaked-Stone Tools

Fifteen flaked-stone tools were identified in Parcel 3. Of the 15 tools, 66.66 percent (n=10) exhibited unimarginal/unifacial modification, that is, flaking on margin and on surface. Three (20.0 percent) exhibited modification on more than one margin. In addition, one biface fragment (6.66 percent) and one biface perform (6.66 percent) were documented. Comprehensively, material type for the flaked-stone tool assemblage consisted of igneous material (6.66 percent/n=1), quartzite (40.0 percent/n=6), and chert (53.33 percent/n=8). With the exception of the one biface fragment, all tools measured between 1.0 cm and 3.0 cm in maximum dimension.

Of particular note, was Specimen No. 38 a steep angles, spurred endscraper. This collected tool was made from a light brown chert and was recovered from surface context.

17.5.4.3 Cores/Tested Cobbles

Twenty-five cores or core fragments were documented during the Parcel 3 survey. Cores were defined as a nuclei from which flakes of varying sizes have been removed (Crabtree 1982). In addition, seven tested cobbles were also identified. Within the core assemblage, lithic materials are differentially represented by quartzite (46.87 percent/n=15) and chert (32.0 percent/n=8). The predominance of quartzite and chert in the core assemblage follows the frequency patterns observed in the documented debitage in both Parcel 1 and Parcel 2. The remaining material types include basalt (4.0 percent/n=1) and sandstone (4.0 percent/n=1). The majority of the complete core assemblage (n=14) occurred in cobble form, the majority of retain cortex (78.57 percent/n=11). Maximum length was also recorded for the complete cores. Core size was measured through a series of size categories previously presented. Five cores measured between 1.0 cm and 2.99 cm in length. Nine cores measured between 3.0 cm and 5.99 cm in size. Again, core size parallels the previous finding, suggesting that available raw material was relative small in size.

Seven tested cobbles were recorded in Parcel 3. Each of the tested cobbles exhibited three or less three flake scars, one measured between 1.0 cm and 2.99 cm, four measured between 3.0 cm and 5.99 cm in size, and two measured between 6.0 cm and 12.0 cm in size. Cortex percentage was between 50 and 100 percent on all seven tested cobbles. Material type included basalt (14.28 percent/n=1), rhyolite (14.28 percent/n=1), and quartzite (71.42 percent/n=5).

17.5.4.4 Hammerstones

Three hammerstones were documented in Parcel 3. All hammerstones were categorized by shape and material, as well as size category. All three of the hammerstones were of coarse-grained quartzite. All three hammerstones were rounded or spherical in morphology. Hammerstone size was measured through a series of size categories, initiated presented under Parcel 1. One hammerstone measured between 1.0 cm and 2.99 cm in size. Two hammerstones measured between 6.0 cm and 11.99 cm in size. All showed clear evidence of battering and pecking.

17.5.4.5 Ground Stone Artifacts

Artifacts identified as grinding implements were classified into three tool types for the survey process: metate, manos, and indeterminate ground stone fragments. Twenty-seven ground stone artifacts were documented during the Parcel 3 survey. The majority (85.18 percent/n=23) of these artifacts were classified as indeterminate ground stone fragments. All of these fragments were made from sandstone, similar in color, texture, coarseness to outcrops in the southern portion of the Laguna Plata site (LA 5148) and along the adjoining ridges. In addition, one unbroken, basin-shaped metate and one metate fragment were documented. The unbroken metate measured approximately 23.0 cm in diameter. This metate and metate fragment were also made from tabular sandstone. One sandstone mano fragment and one unbroken limestone mano completes the ground stone assemblage identified in Parcel 3.This mano measured between 8.0 cm and 12.0 cm in diameter.

17.5.4.6 Ceramic Assemblage

The ceramic assemblage recorded within Parcel 3 consisted of seven sherds. Four Jornada Brown body sherds were documented, as well as one El Paso Polychrome rim sherd and one St. Johns Polychrome body sherd. Finally, a single unidentified body sherd was provided point provenience and mapped in the this parcel. The Jornada Brown sherd suggests a temporal setting ranging between A.D. 200.400 and 1250/1350. El Paso Polychrome dates between A.D. 1200/1250 and 1450, while St. Johns Polychrome dates between A.D. 1200 and 1300 (Wiseman 2002, 2003).

17.5.4.7 Artifacts-Other

Six artifacts were classified as other in the Parcel 3 survey. These artifacts included two small (<3.0 cm) indeterminate bone fragments and three small (<3.0 cm) indeterminate mollusk shell fragments.

17.5.5 Parcel 4

Parcel 4 was placed in the southeast portion of the basin, along the west facing alluvial fans (Figure 4). This parcel was established in anticipation of geomorphologic-oriented mechanical trenching. Parcel 4 is south of LA 145247 and north of LA 22107, but does not breach either prehistoric site (Higgins et al. 2004). Unlike the previous survey blocks, which should be viewed as extensions of the Laguna Plata site (LA 5148), Parcel 4, and the subsequent Parcel 5, are not part of LA 5148. As such, cultural materials recorded within these two parcels were documented as isolated occurrences.

The survey block encompassed the margins of west-trending alluvial fans and portions of a small spring-fed playa. The topography within the northeast portion of Parcel 4 sloped slightly to the west with small dune development, salt cedar marsh, and grassland comprising the majority of the vegetation (Figure 5). The southeast corner of the parcel was characterized by a small ridge or crest along the playa margin (Figure 6). This area contained sediment accumulation, small mesquite and grass stabilized dune development, and exposed paleosol surfaces. The remaining portions of the parcel fell within the playa proper and along the adjoining playa margins.

Figure 17.4 Artifact distribution within Parcel 4

Figure 17.5 General overview of Parcel 4 looking northwest

Figure 17.6 Overview photograph of isolated occurrences, looking southeast

17.6 Isolated Occurrences

During the course of the survey, four isolated occurrences were documented. All four were identified along the small ridge in the southeast corner of the parcel. All were positioned on exposed surfaces or paleosols. These artifacts are presented below.

17.6.1 Isolated Occurrence 1

Amethyst bottle fragment 7.0 cm in length. This fragment included the bore opening, lip, and neck of the bottle. A horizontal seam was noted directly below the lip and neck. A lateral seem down the neck of bottle was also noted. The long-axis seem terminated at the neck/lip juncture (Figure 7).

Amethyst glass is the result of adding manganese to the sand mixture and exposing the glass to ultraviolet rays for an extended period of time. Manganese, first used in 1880, was originally added to decolorize glass; however, after extensive exposure to the sun, the glass color would result in light to dark purplish glass. The use of manganese in clear glass production virtually stopped in the United States in 1915 during WWI, since Germany was the leading exporter of manganese (Fike 1987:17; Condon et al. 2010a:211). Based on use of manganese in glass production, the three amethyst glass shards date from 1880–1915 (Baugher-Perlin 1982).

17.6.2 Isolated Occurrence 2

Flaked-stone tool, approximately 8.0 cm in length (see Figure 7). This tool was made from purple quartzite cortical flake. Flake scars were observed along both lateral margins, but on only the dorsal face. This isolate was exposed along a paleosol south of Isolated Occurrence No. 2.

17.6.3 Isolated Occurrence 3

Two small aqua-green bottle glass shards, measuring less than 3.0 cm in length. Both shards were identified along dune margin at the southern end of a small ridge. No embossing or mold seems were observed. Copper was added to the silica of bottles circa 1850, and when exposed to ultraviolet light turned an aqua/green color. Although aqua/green colored glass is still made today, production generally ceased in the 1920s.

17.6.4 Isolated Occurrence 4

Two small amethyst bottle glass shards, measuring less than 3.0 cm in length. Both shards were identified along dune margin at the far southern end of a small ridge. No embossing or mold seems were observed.

Figure 17.7 Isolated Occurrences 1 and 2

a) IO 1, amethyst bottle fragment, b) IO 2, flaked-stone tool made from quartzite

17.7 Parcel 5

Parcel 5 was placed in the east/central portion of the basin, along the west facing alluvial fans (Figure 8). This parcel was established in anticipation of geomorphologic-oriented mechanical trenching. Parcel 5 is south of LA 145248, but does not impact this prehistoric site (Higgins et al. 2004).

The survey block encompassed the margins of west-trending alluvial fans and portions of a small spring-fed channel that empties into the Laguna Playa. The topography within Parcel 5 sloped slightly to the central spring channel and a small associated wet land. Mesquite-stabilized dune development and grassland comprising the majority of the vegetation and restricted visibility in much of the survey parcel (Figure 9).

17.7.1 Isolated Occurrence

During the course of the survey, one isolated occurrence was documented. This isolate was identified along the south facing alluvial slope in the northwest corner of the parcel. Artifacts were positioned in a linear fashion following a shallow rill and lacked contextual integrity.

17.7.1.1 Isolated Occurrence 1

This occurrence consisted of a small scatter of burned-caliche fragments observed within a shallow rill or arroyo in the northwest corner of the parcel (Figure 17.8). These nine fragments measured less than 5.0 cm in diameter and were loosely associated between grass hummocks. In addition, a single tabular sandstone fragment was noted, but lacked definable modification attributes. This occurrence lacked contextual integrity.

Figure 17.8 Artifact distribution within Parcel 5

Figure 17.9 Overview photograph of Parcel 5, looking northeast, southwest parcel corner in forefront

Figure 17.10 Isolated Occurrence 1, Parcel 5, burned-caliche fragments and tabular sandstone fragment

18.0 Conclusions

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This chapter summarizes the results of the investigations and assesses them in terms of the research issues outlined in Chapter 5. The summary data are followed by a discussion that integrates research issues into an interpretation of prehistoric land use. The research issues are predicated in part upon our current understanding of the culture history of the Jornada Mogollon region and the characteristics specific to LA 5148. The research topics identified include the following: chronology and cultural affiliation, site structure and organization, assemblage diversity, organization of technology, settlement patterns, subsistence activities, and patterns in regional interaction.

18.1 Chronology and Cultural Affiliation

Establishing the site chronology involved a multistage process that relied heavily on both AMS-dating techniques and diagnostic artifacts. This strategy integrated type correlates that included relative dates provided by diagnostic ceramics and projectile-point assemblages. Cross typing of artifacts against the radiocarbon assays strengthened the interpretation for site occupation and provided a link between temporal and material correlates with regard to diagnostic artifact types.

Twenty (n=20) pottery types were identified, most of which were collected from the C-10-C locus excavated by LCAS and ENMU-ACA. This assemblage included Jornada Brown, Jornada Decorated, South Pecos Brown, Middle Pecos Brown, McKenzie Brown, El Paso brownware, El Paso Brown rim sherds, El Paso Bichrome, El Paso Polychrome, El Paso Decorated, Alma Plain, Mimbres Black-on-white, Playas Red, Chupadero Black-on-white, Three Rivers Red-on-terracotta, Lincoln Black-on-white, Corona Corrugated, St. John's Polychrome, Ramos Polychrome, and Gila Polychrome. An additional class was established for pottery that could not be placed into a known category. Local Brownware variants, specifically Jornada Brown (67.73 percent/n=2,106), comprise most of the ceramic assemblage collected from LA 5148.

The ceramic assemblage provides a relative age estimate for site use. Of the ceramic types identified in the combined TRC and LCAS collections, 17 were identified within the collection that were greater than 3 cm diameter (n=3,109). Three additional types (Middle Pecos Brown, McKenzie Brown, and Alma Plain) were identified in the sample that measured less than 3 cm diameter (n=4,517). Of the 20 types identified in the total ceramic assemblage, 17 aid in refining the occupation at LA 5148. While providing a general timeframe for the site, pottery types Jornada Brown and Jornada Decorated (A.D. 450–1350), as well as El Paso brownware (A.D. 200/400–1450) yield only broad-age estimates by which to date LA 5148. More informative are the remaining types, which all have shorter age spans, and subsequently, provide a more accurate tool for interpreting time of site occupation.

Based on the ceramic assemblage three periods of site use during the Formative period are identified. The presence of El Paso Brown (A.D. 200/400–1100), South Pecos Brown (A.D. 900–1200), Middle Pecos Brown (A.D. 500/900–1300), Alma Plain (A.D. 200/400–650), and Mimbres Black-on-white (A.D. 850–1150) all suggest a pre-A.D. 1100 occupation. A second period of occupation occurred between A.D. 1100 and 1300, which is supported by the highest frequency of pottery types. McKenzie Brown (A.D. 1100–1300), El Paso Bichrome (A.D. 1100–1250), El Paso Decorated (A.D. 1100–1450), Playas Red (A.D.

1150–1450), Chupadero Black-on-white (A.D. 1100–1300), and Three Rivers Red-on-terracotta (A.D. 1100–1300) not only show evidence for possible increased site use, but an increase in regional interaction during this period as well.

El Paso Polychrome (A.D. 1200/1250–1450), Corona Corrugated (A.D. 1225–1460), Lincoln Black-on-white (A.D. 1300–1400), and Gila Polychrome (A.D. 1300–1400) are dated post A.D. 1200. The narrow production range of these nonlocal pottery types suggests use of LA 5148 continued well into the Fourteenth century with a terminus date of circa A.D. 1400/1450. This stands in contrast to Haskell (1977) who interpret the abandonment of LA 5148 by A.D. 1350.

Haskell (1977) present the analysis of 375 pottery sherds recovered by the LCAS from C-10-C, also identified as Feature 1. Haskell (1977) conservatively recognized 25 pottery types, some with subtle differences in temper, color, and paste. This assemblage can be subdivided into three primary time frames: A.D. 200/400–1100, A.D. 1100–1300, and post-A.D. 1300. The earliest age bracket of A.D. 200/400–1100 includes El Paso Brown and South Pecos Brown pottery types. The middle bracket of A.D. 1100–1300 only spans 100 years, but includes El Paso Bichrome, Roswell Brown, Chupadero Black-on-white, Three Rivers Red-on-terracotta, and possibly brownware polychrome. Pottery types dating after A.D. 1300 include El Paso Polychrome, Lincoln Black-on-red, Gila Polychrome, Ramos Polychrome, and Tabira Black-on-white. With the exception of Tabira Black-on-white (A.D. 1550–1650), interpreted as the general successor to Chupadero Black-on-white, all ceramic types terminate by the second half of the Fifteenth century. The presence of Tabira Black-on-white, which originates in the central New Mexico region, reflects a late occupation at LA 5148. However, the small sample group (n=2) and the lack of evidence pointing towards a post A.D. 1400/1450 component at the site suggests the two Tabira Black-on-white sherds may be, in all likelihood, Chupadero Black-on-white variants. As such, the ceramic assemblage shows evidence for frequent site use throughout the Formative period, but with greater intensity during the Formative IV through VII phases.

Seven projectile points or point fragments were recovered during TRC's testing at LA 5148. Of the seven, five projectile points have diagnostic attributes that allow for the application of a type classification. The earliest collected projectile points are typed as Leslie's 5-A and 5-B variants, which exhibit deep corner-notching, expanding stems, and well-defined shoulders that form small, downturned barbs. Leslie (1979) dates these projectile points types between A.D. 800/850 and 1000, suggesting a Formative II through III phase, which correlates with the earlier ceramic types recovered at the site. Catalog Numbers 34, 62, and 166 most resemble Leslie's (1979) Type 5-A and 5-B variants. A Fresno (A.D. 800–1800) triangular point, which correlates with Leslies (1979) 1-A and 1-C variants was also collected during the survey as well as a Starr variant, which dates between A.D. 900 and 1800. The projectile point assemblage spans the entirety of the Formative period in southeastern New Mexico paralleling the majority of the pottery types that are identified in the region post A.D. 800 and after the initial Formative period fluorescence. The projectile point assemblage primarily correlates with ceramic types that date post-A.D. 800, inferring that the most intense site use is during and after the Formative II phase.

Haskell (1977) provides data on 27 of 29 projectile points recovered from Locality 2, Feature 1, also known as C-10-C, the LCAS excavation area. The 27 projectile points and projectile point fragments span the range of the Formative period with only one specimen dating to the Archaic (Tortugas variant: 4000 B.C.–A.D. 1000). Closer analysis identified three temporal clusters. The first cluster includes Leslie's (1979) Types 5-A, 5-B, 6-A, and 6-B, which date between A.D. 800 and 1100. The second cluster includes Leslie's (1979) Types 3-A, 3-B, and the Nolan variant (A.D. 950–1200). Cluster three dates between A.D. 1200 and 1500 and includes Leslie's (1979) 2-A, 2-B, 2-C, 2-F types, a Young variant, and an unidentified Late Ochoa phase projectile point. The remaining point types extend over multiple phases, precluding the development of a more refined temporal chronology. Review of the projectile point data tentatively indicates increased site use after A.D. 800, with possible greater usage after A.D. 1200.

18.1.1 Summary

Results of the chronometric analyses suggest the radiocarbon ages from Features 2 and 3 are in suitable association within an aggrading depositional environment. The radiocarbon age of Feature 6 was also used to estimate the age of the site and corresponds with the age of Feature 2. This interpretation differs from one initially advanced by Runyan (1971), suggesting that the two pit houses are contemporaneous. Reconciling the dissimilar ages is difficult due to the small sample selection. In this case, the age estimates seem accurate, but without further organic evidence, the interpretation is limited. Despite the difference in age, it is suggested that the two pit houses were intrusive into the same alluvial surface, and while not contemporaneous, utilized a familiar topographic landform. Similar structures are present at the site and additional collections may improve our conceptual model of prehistoric land use at LA 5148.

The radiocarbon ages provide a first order means for dating the site. In comparison, the assemblage data provides evidence for site activity during the late Archaic through the late Formative period. The available data focusing on the ceramic and projectile point assemblage is coarse, but lends itself to targeting temporal changes in occupation at the site. The duration of site activity based on the ceramic assemblage suggests reoccupation throughout the Formative period. The presence of intrusive pottery types, however, allow for defining at least three periods of increased site use: 1) A.D. 200/400–1100, 2) A.D.1100–1300, and 3) A.D. 1300–1450. These age brackets are thought to reflect activities oriented around seasonal site use and potential targeting of this specific landform during the Formative period. As Railey, Rissetto, and Bandy (2009) hypothesize, landform selection may shift during the Formative period towards specific habitats that enable access to more reliable water sources, resource procurement and/or arable soils. After A.D. 1000 there are more extensive occupations with a decrease in site use, (possibly site abandonment) by A.D. 1450. This is supported in part by the projectile point data, which also indicates a greater frequency in artifact type occurrence from 1) A.D. 800–1100, 2) A.D. 950–1200, and 3) A.D. 1200–1500. These three age estimates generally correspond and strengthen the occupational hypotheses presented elsewhere in this chapter.

Current research carried out by Railey, Rissetto, and Bandy (2009) and aggressive radiocarbon sampling conducted by Lord and Reynolds (1985), Staley (1996), Wiseman (2003), and recent work by Simpson (2010) there is becoming a more reliable chronometric control of the archaeological record in southeastern New Mexico. However, nearly 55.9 percent (n=124) of the conventional radiocarbon dates acquired several years ago (see Railey, Rissetto, and Bandy (2009:Appendix I) have standard errors greater than 50 years. As stated throughout Hogan (2006), good radiocarbon dating in southeastern New Mexico requires not only careful collection and meticulous chemical and radiometric analysis, but also consideration of the biochemistry of the carbon source. Moreover, pursuing a more aggressive regiment of sampling data from suitable contexts throughout the region may provide an elevated level of chronometric control and further our understanding of the region.

The recent dating of 48 features at seven sites in the Mescalero Sands yielded dates associated with early Archaic through late Formative occupations. The 48 dates include 10 Archaic I, 6 Archaic III, 7 Archaic IV, 10 Formative I, 15 Formative II, 1 Formative III, 4 Formative IV, and 2 Proto-historic-Present features (Simpson 2010:302). These sites in the Mescalero Sands retained fairly stable surfaces that were occupied repeatedly from the Archaic through the middle Formative periods. Periods of most intense occupation appear to have occurred from about 5500–2000 B.C., around 1000 B.C., from about A.D. 1 to 950, a short period of abandonment of the region followed by more intense occupation of the region from about A.D. 1075 to 1125 and abandonment again until after A.D. 1400. These earlier dates of occupation in the region tend to correlate with the interpretations for the Laguna Plata site (see above), from A.D. 200/400–1100 and A.D. 1100–1300, but do not necessarily correlate with the later dates. Obviously, there needs to be refinement in the chronology for the region. Although informative and helpful, the conventional and AMS dates from the seven excavated sites in the Mescalero Sands (Simpson 2010) exhibit standard errors of ±40 (42 percent of 48 dates) to ±60 (35 percent of 48 dates). Unfortunately, these resolutions are not conducive to better chronometric control and further work needs to be done.

18.2 Spatial Analysis: Site Structure and Organization

Analyses conducted in conjunction with the first research domain provided the framework for addressing two subsequent research domains: 1) site context and 2) site structure. Site context refers to the state in which archaeological deposits are encountered and how the relationship between artifact and environment can be used to interpret past human behavior. The ability to address the second research question is partially, if not wholly, dependent on the answer to the first. Site structure refers to the distribution of artifacts and features within a site and the functional, temporal, and spatial patterns associated with these material remains within a finite space (Hodder and Okell 1978; Schiffer 1976; Simek 1989). As such, the fundamental objective to pattern recognition is identifying limited activity areas or special-task loci as defined by a specific tool kit or the co-occurrence of artifact classes in an effort to interpret prehistoric adaptive strategies (Schiffer 1976; Simek 1989). Following Simek (1989:59), the application of point provenience techniques is valid only if the distributional structure, or contextual integrity of a site, indicates specific behavioral events may be preserved. The depositional processes associated with LA 5148 provides an increased level of preservation despite the ongoing aeolian and alluvial movement of sediments. In fact, the overlying aeolian sediments associated with coppice dune development acts to stabilize the underlying anthrosols identified in the northern and central portions of the site.

Based on the results presented in Condon et al. (2008b), and Miller (2007), several statistical measures of distance were selected in identifying and interpreting distribution patterns present in the archaeological record. The spatial analysis methods selected for this project included Kmeans clustering, Hodder and Okell’s A statistic, and Nearest Neighbor statistic, all of which are found in Kintigh’s Tools for Quantitative Archaeology software package (Kintigh 1998).

Spatial data sets were generated by point provenience mapping of surface artifacts and features. Data recovered from the point provenience method were exclusively used for the Kmeans clustering, Nearest Neighbor, Hodder and Okell’s A statistic. The graphic density maps were produced using all available data sets analyzed with the three analyses methods. In addition, a site density map of raw counts was generated as a means of assessing the spatial context of the site. The initial site mapping process documented artifacts and features using an electric distance measuring device (i.e., EDM) from a fixed point (i.e., the TRC datum). Subsequently, data sets recovered from LA 5148 were examined through spatial distribution programs to evaluate intrasite levels of dispersion. Of interest were identifiable patterns in artifact distribution that could be correlated with potential limited-activity areas or special-task loci. Subsequent to establishing the horizontal provenience of surface artifacts, the nonhierarchical statistical program of Kmeans was implemented to determine intrasite cluster patterns based on location. This program minimizes the cluster variation within a single data set while maximizing the variation between multiple data sets (Gregg et al. 1991:153).

18.2.1 Kmeans Cluster Analysis

Cluster analysis provides the first critical step in defining and interpreting spatial data by classifying groups of x and y provenience points into homogenous subgroups (Hodson 1970:299). The cluster analysis program provided a set of criterion, and in this case, distance data. After these data sets were entered into the system, the software program separated the numerical variables into statistically relevant clusters. The program first assembled the total data set in aggregate, which was represented by a single circle or cluster. The center of each circle represented the mean values of the x and y coordinates for a single, comprehensive data set. The single cluster was then repeatedly subdivided forming a new cluster arrangement. This process continued until the maximum number of clustering events had been reached.

Kintigh and Ammerman (1982) refer to this process as the SPLIT procedure and provide a descriptive interpretation for the Kmeans calculations:

The distance from each point to its cluster configuration is computed. Next, the point farthest from its assigned cluster centroid is split off to form a new cluster. After this, each point, which is now closer to the new cluster centroid than to its own, is assigned to the new cluster and the affected centroids are recomputed. Then, another pass is made through the points to re-allocate each point to the cluster with the closest centroid. The result of this procedure is that one additional cluster is formed and the square root of the standard sum error (SSE) is reduced (Kintigh and Ammerman 1982:39).

Refinement was achieved as each level of clustering was statistically generated until all possible clustering events were exhausted. As such, cluster solutions were produced for the distribution of one to 30 events for each assemblage. The resulting percent SSE were analyzed to identify whether statistically significant clustering events were present where the significant points of variable aggregation were located. A single cluster configuration pattern was selected for each cultural assemblage. The clusters were examined for patterns in artifact type variation and spatial relationship to datable features.

A Kmeans cluster analysis was performed using point provenienced artifacts and features mapped at LA 5148. Figure 18.1 illustrates the linear relationship between the input data (location) and the random-runs data. If the input data line (in this case, the lower solid line) falls below the mean value line (the dashed line between the random-runs dotted lines), then statistically significant clustering events are indicated. Irregularities along the smooth data line correspond with clustering events identified during the 30 random runs generated by the program. To aid in interpreting the spatial and contextual integrity, a contour map of the site and artifact distribution was created for comparison to the cluster configurations. A visual analysis of the Percent SSE data indicates the 13-cluster configuration was the most visually explicit of the groupings (Figure 18.2).

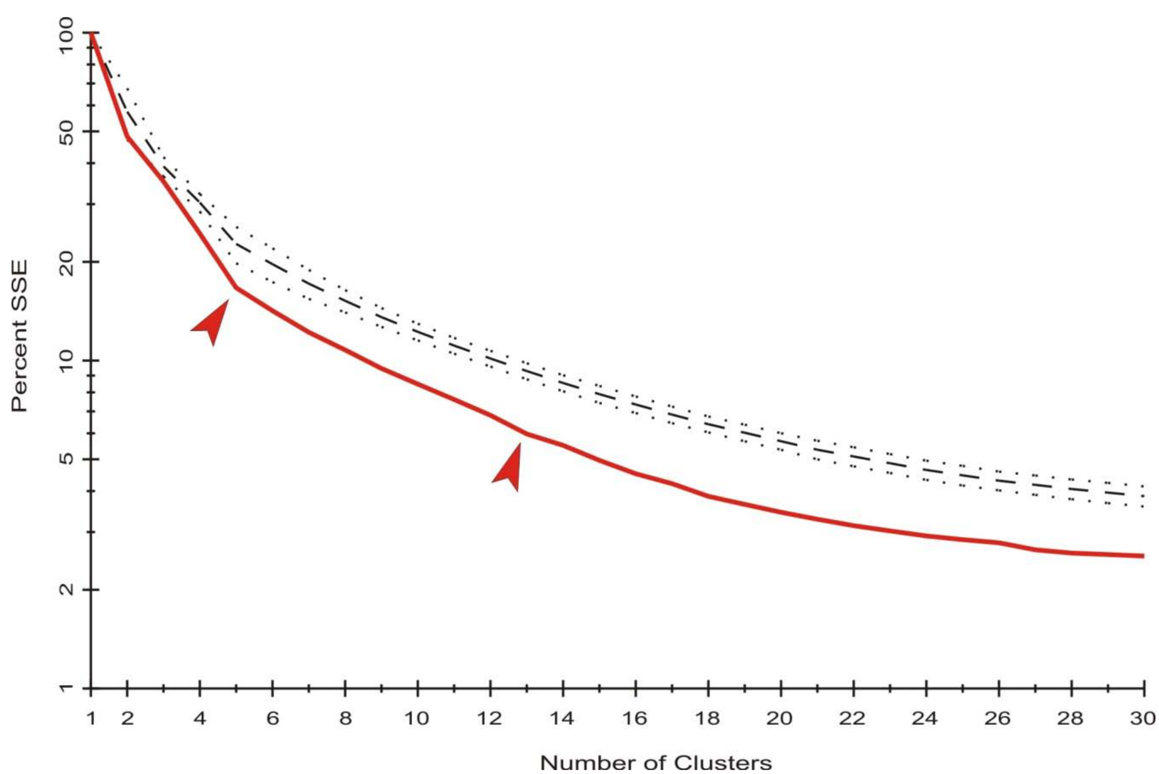

Figure 18.1 Percent SSE random data plot for LA 5148

The spatial data generated by the Kmeans program produced a distribution pattern that encompassed much of the central and north-central portions of the site, with the most notable aggregations identified along the most prominent ridge forms north and south of the two-track access road. The remaining artifact aggregations were limited in number and spread throughout the northeastern and southwestern portions of the site. These two areas are characterized by differential deflation; most severe in the southern half of the site. Artifact clustering immediately north of the two track road is associated with a rich organic deposit interpreted as an Ab soil horizon/anthrosol and with dune development closest to the playa margin. It is unclear whether artifacts within the organic deposit retain contextual integrity as the process of soil development, bioturbation, and local collecting since all contributed to minor and major disturbances. Artifacts within the deflation basin reflect lag deposits; however, the dunes adjacent to many of the artifact clusters may cover intact cultural deposits. Capped features and artifacts eroding out from the dune margins, most notably in the northeast boundary of the site, indicate the presence of buried cultural deposits.

Immediately south of the two-track road is an area of sediment accumulation and dune development that demarcates the transition between intact soils and deflated paleosols. Artifact aggregation is associated with intact features and buried Ab soil horizons in level areas along the ridge top. Artifacts lying along the sloping ridge margin reflect a secondary context. Artifact spatial positioned within the Ab soil horizon and eroding from the dunes may indicate discrete, medium to high occupation zones.

Using the Kernel Density application in ArcGIS, a raster map was generated that graphically displays the density of points, in this case, artifacts and features, within a bounded environment (i.e., site boundary). This tool calculates a non-parametric estimate of site density by subdividing the bounded environment into individual cells, or kernels (Silverman 1986). Provenience points (e.g., artifacts) that fall within each raster cell/kernel are counted and the values added (Silverman 1986). A smoothed curved surface is placed over each point, resulting in a contour map reflecting density of cells in relation to the bounded environment, LA 5148. Density values are greatest, reflect the highest frequency, along the line, and diminish as they move away from the line. This is graphically displayed in the transition from a dark blue to lighter-blue color. The raster map was then overlaid on an aerial map of the site and correlated to square meters (Figure 18.3).

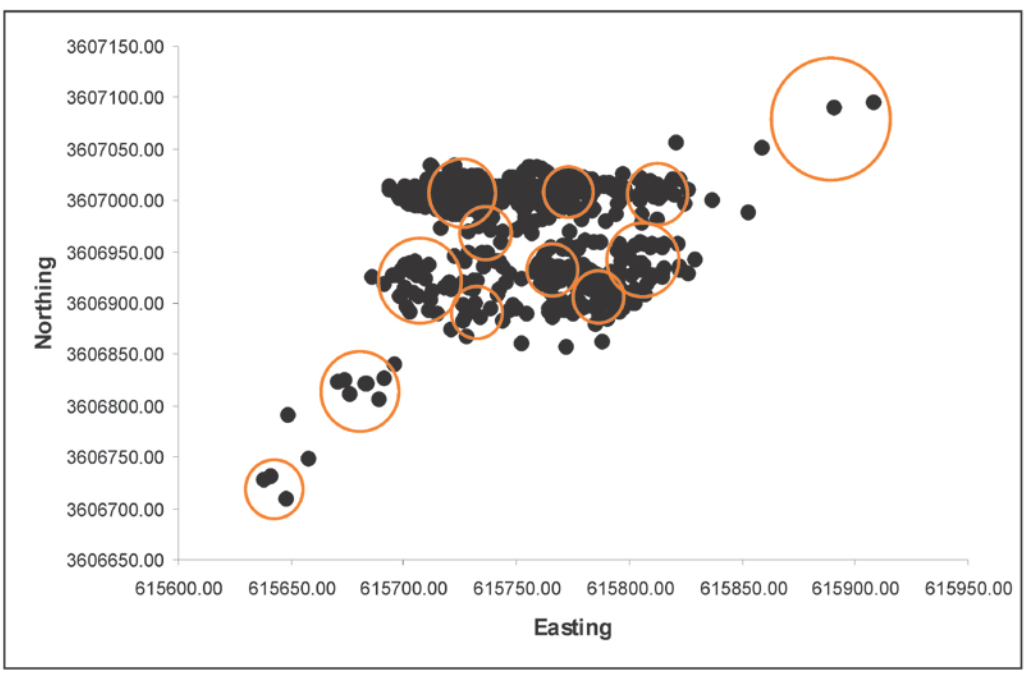

Figure 18.2 Kmeans 13-Cluster configuration for LA 5148

The results of the kernel density map effectively illustrate the findings of the Kmeans cluster analysis in a graphical manner. Spatially relevant artifact clusters are noted immediately north of the two-track access road, and south of the road along the ridge top. The area immediately north of the two-track access road contains a well-developed anthrosol that may blanket buried cultural deposits, resulting in a low frequency of surface features. Surface artifacts are most prevalent in this portion of the site and are intermingled with the anthrosol. This area of the site has been adversely impacted by local collectors as documented by Haskell (1977) and as indicated by the geophysical survey discussed in Chapter 8.

In addition, the density of artifacts is also noted in the south-central portion of the site. The presence of spatial related cultural manifestations in this portion of the site is the result of stratigraphic stability in which artifacts exhibit horizontal integrity. Lending support to site stability is a well-established Ab horizon noted throughout the central portion of the site. Features and surface artifacts are intermingled in shallow deflation basins, eroding out of dunes, and exposed in shallow rills and arroyos. Each of the four main areas highlighted in darker blue correlate with areas of accumulated sediments and observed organic-rich soils, and to a lesser extent, areas of aeolian deflation. Areas not included in the raster map represent portions of the site that contained less than five artifacts per square meter. Over time this number may increase or decrease depending on ground cover and sediment displacement. This measure suggests a low density of artifacts at the time of the TRC site survey. Closer examination of these areas identified both deflated surfaces and surfaces covered in low-relief dunes and sand sheets. While these portions of the site may yield buried cultural deposits, the dark blue zones merit further attention. The elevated terrace in many ways offers preserved contextual integrity and the highest potential for additional buried structures at the site. The marginal portions of the site stand in contrast, with extreme deflation noted and the absence of the Ab soil horizon.

18.2.2 Nearest Neighbor Statistic

The Nearest Neighbor statistic is useful for testing hypotheses regarding the clustering, randomness, or uniformity of spatial distributions. In this application, the statistic is used to assess the distribution of artifacts and the co-occurrence of artifacts and features across a site. Nearest Neighbor Analysis measures the linear distance (r) from any given point to the closest adjacent point (Clark and Evans 1954; Durand and Pippin 1992). The distances are averaged to produce a mean distance value and a standard deviation value. The mean is divided by the square root of rho, where rho is the density of points on a map or (n-1)/A and A is the total area the points occupy. The measure of randomness (r) is the ratio of observed and expected mean distances (Hodder and Orton 1976). The resulting coefficient value is measured as 0 (maximum clustering), 1.0 (random distribution), and 2.29 (uniform pattern) (Clark and Evans 1954; Hodder and Orton 1976).

The Nearest Neighbor coefficients were calculated for all artifacts and features documented during the TRC survey (Table 18.1). Initially Nearest Neighbor analysis was conducted on the general surface data set in an effort to test the previous cluster analysis results and evaluate the spatial distribution of cultural materials across the site. The Nearest Neighbor statistic was conducted for between group associations for 14 artifact types. The resulting coefficient values indicated a co-association between artifacts and/artifact and features that is more representative of the spatial relationships present at the site (Table 18.1). Coefficient values approximating 0 reflect absolute clustering. Values approximating 1.0 indicate a random distribution of artifacts. For this study, values falling below 0.50 were considered significant in regard to spatial aggregation and tentatively interpreted as a possible cultural relationship. Row values tentatively indicate several spatial relationships.

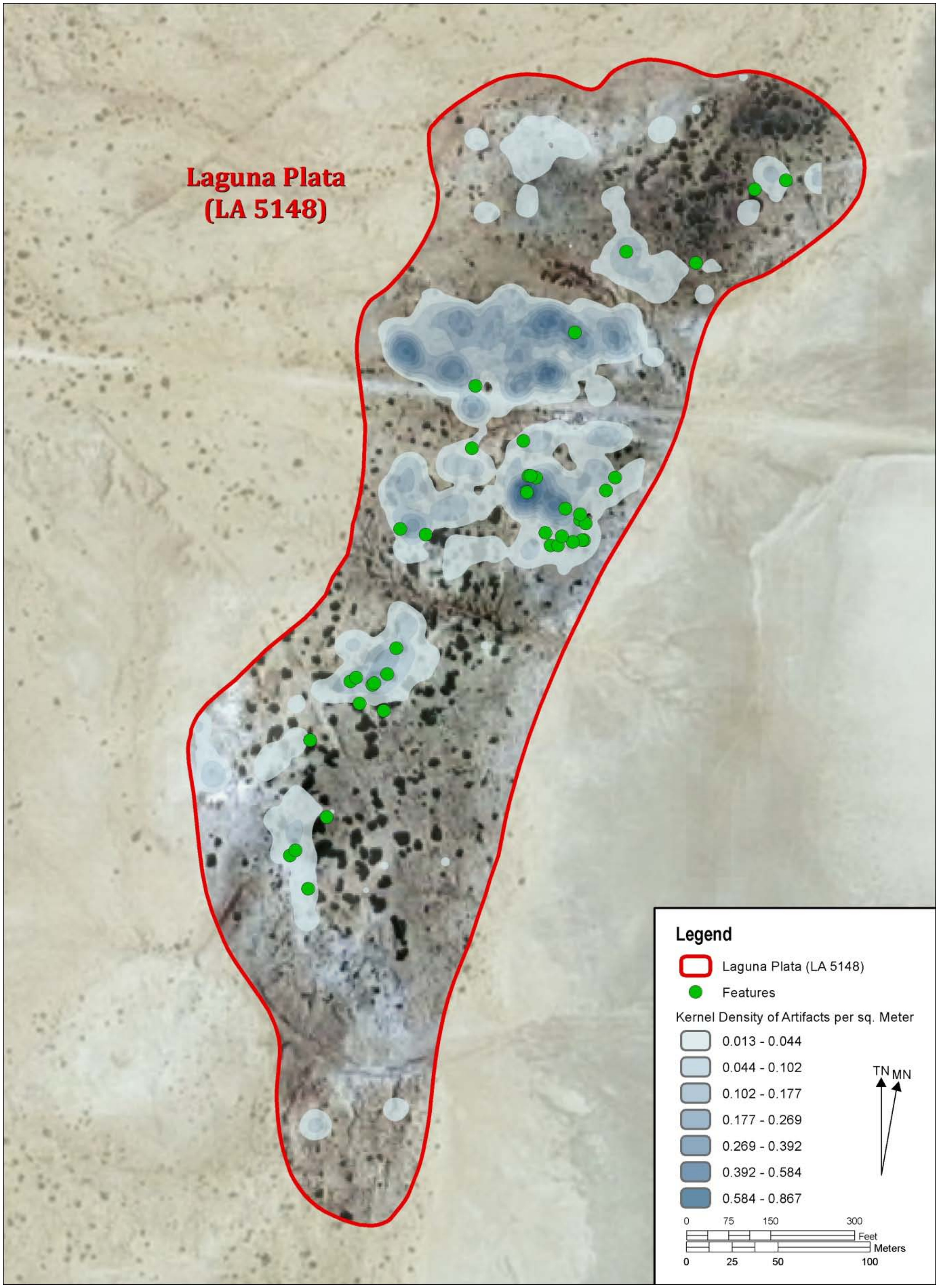

Figure 18.3 Kernel density map for LA 5148

Spatial relationships are indicated at LA 5148 and include bone fragments and lithic debitage (value 0.12). Other prominent relationships are identified for the pestle fragment and flaked-stone tools (coefficient value of 0.20), pestle fragment and indeterminate ground stone (coefficient value of 0.21), and pestle fragment and shell (coefficient value of 0.14). While these three relationships are somewhat misleading due to the single occurrence of a pestle fragment, they do warrant attention towards recognizing spatial and cultural organization at the site. The presence of shell in association with flaked-stone tools is indicated by a coefficient value of 0.31, which may also suggest a spatial as well as a functional relationship. Finally, the co-occurrence of projectile points and cores (coefficient value of 0.47) and hammerstones and cores (coefficient value of 0.49) moderately implies a spatial/functional relationship that infers tool manufacture and maintenance. Interestingly, the coefficient values associated with features indicate a relatively minimal spatial association with other artifacts. Three associations are worth discussion: features and projectile points, features and shell, and features and bone. Each of these pairings indicates a co-occurrence between categories. In the case of projectile points and features, a coefficient value of 0.59 was generated. Coefficient values of 0.61 and 0.66 were generated, respectively, between features and shell, and features and bone. The spatial relationship between features and resource processing is of interest and reveals potential subsistence activities at the site.

Table 18.1 Nearest Neighbor coefficient values for LA 5148

Artifact Type	Lithic Debitage	Flaked-Stone Tool	Core	Projectile Point	Hammer-stone	Ceramic	Mano	Metate	Indeterminate Ground Stone	Shell	Bone	Pestle	Tested Cobble	Feature
Debitage (n=1012)	0.39	0.55	0.53	0.67	0.54	0.68	0.75	0.89	0.80	1.38	1.62	0.56	0.86	0.89
Flaked-Stone Tool (n=86)	1.03	0.65	0.89	0.87	0.80	0.79	0.98	1.15	1.26	1.80	2.87	0.72	1.11	1.09
Core (n=147)	0.65	0.58	0.60	0.74	0.58	0.70	0.70	0.9	0.85	1.49	1.97	0.62	0.88	0.92
Projectile Point (n=7)	0.71	0.60	**0.47**	1.13	0.52	0.74	0.87	0.71	0.90	1.62	1.83	0.62	0.92	0.59
Hammerstone (n=42)	0.58	0.54	**0.49**	0.66	0.80	0.82	0.67	0.89	0.80	1.39	1.72	0.53	1.01	0.97
Ceramic (n=57)	0.96	0.78	0.88	0.67	0.85	0.65	1.07	0.99	1.25	2.59	4.15	0.89	1.08	1.02
Mano (n=43)	0.78	0.69	0.72	0.74	0.64	0.67	0.72	0.91	0.86	1.11	2	0.51	1.18	1.17
Metate (n=60)	0.73	0.68	0.75	0.81	0.76	0.62	0.73	0.58	0.99	1.67	2.37	0.61	1.05	1.1
Indeterminate Ground Stone (n=128)	0.39	0.64	0.53	0.69	0.57	0.58	0.89	0.79	0.47	1.07	1.36	0.57	0.96	0.78
Shell (n=43)	0.54	0.65	0.31	0.62	0.53	0.76	0.52	0.67	0.60	0.34	0.96	**0.36**	1.10	0.61
Bone (n=94)	**0.12**	**0.39**	**0.35**	**0.39**	**0.37**	0.50	0.53	0.63	0.46	0.59	0.32	**0.36**	0.81	0.66
Pestle (n=1)	0	**0.20**	**0.38**	0.5	0	0	0.36	0.75	**0.21**	**0.14**	0.71	0	1.15	1.05
Tested Cobble (n=13)	1.59	1.11	1.19	0.99	1.02	1.03	1.26	1.08	1.68	3.85	5.24	1.20	0.81	1.06
Feature (n=40)	0.85	0.62	0.56	0.64	0.63	0.68	0.83	0.78	1.07	2.31	2.97	0.86	0.94	0.52

18.2.3 Hodder and Okell's A Statistic

Hodder and Okell's A statistic also measures variation in distance between and among different artifact classes within a finite space. A statistic approximates 1.0 if the distance between points, in this case artifacts and features, is statistically close or aggregated. The farther the A statistic deviates from 1.0 (< 0.99), the greater the degree of randomness and a lack of a spatial relationship between artifacts or features (Hodder and Okell 1978; Kintigh 1998). One advantage to Hodder and Okell's (1978) analytic techniques, as presented by Miller (2007), is the A statistic is not affected by edge or boundary conditions. Simply stated, the spaces used to define a data set have boundaries and edges (e.g., site boundary); however, many times a point may fall outside of this finite dimension (Hodder and Orton 1976). Observations that fall outside of a bounded area may still hold significance, but are omitted during certain spatial analyses (Hodder and Orton 1976). The Hodder and Orton A analysis of association is not affected by this dimension problem.

It is important to note the boundary effect of the Nearest Neighbor statistic. As presented earlier, the spaces used to define a data set have boundaries and edges (e.g., site boundary) and can affect the accuracy of statistical calculation (Hodder and Orton 1976). Hodder and Okell's A statistic was used to correct for inaccuracies and as a final assessment of spatial integrity at LA 5148. The results of Hodder and Okell's A statistic provided somewhat different results when compared to the Nearest Neighbor statistic (Table 18.2).

The resulting A coefficient value indicates a spatial association between projectile points (n=7) and a variety of other artifact types. The co-occurrence of hammerstones and projectile points (coefficient value of 1.06), cores and projectile points (coefficient value of 1.04), and debitage and projectile point (coefficient value of 1.03) support the nearest neighbor findings of possible tool manufacture and maintenance. A coefficient value of 1.02 for projectile points and features and indeterminate ground stones is less direct, but suggest multiple activities may be linked to the organization of tool technology. These artifacts are closely related across space, tentatively suggesting many of the relationships are oriented around multiple activities. The coefficient value of 1.02 between hammerstones and manos suggests a spatial relationship. This relationship infers the possibility of two activities, or perhaps, that hammerstones were also multifunctional, serving as a pulping/grinding tool as well as a percussion tool.

18.2.4 Summary

With regard to the community patterning and differential use of space at LA 5148, there is a distinction in the placement of features along elevated ridges and fans. Moreover, a spatial relationship between features and specific artifact types is indicated by the statistical analysis. In this regard, the spatial statistics are helpful in identifying the co-occurrence of specific artifact types. The aggregation of multiple artifact types across the site suggests a nonrandom use of space and a salient expression of complexity in community layout. This complexity obscured the intermixing of occupational events through time, all indicating a variety of activities, seasonal orientation, and occupational duration. On the other hand, it is difficult to discern logistical activity at the site, which may be ephemerally expressed in the spatial data.

While the application of spatial patterning and the use of distance as a mechanism for evaluating the relationships between artifact types and features offers a significant tool in a comparative context, several cautions are warranted. Problems are inherent in the sample size effect and in the interpretation of culture versus nature as causal factor to spatial patterning. The use of spatial patterning techniques does offer interesting results in the clustering of artifacts and the inherent implication of discrete activity areas. Thus, subsequent to identifying spatial correlations between artifact types, inferences identifying activity structuring on an intra-site level of investigation are critical to the interpretation of past human behavior and the continued use of spatial patterning as a technique of archaeological explanation.

Table 18.2 Hodder and Okell's A-Statistic values for LA 5148

Artifact Type	Lithic Debitage	Flaked Stone Tool	Core	Projectile Point	Hammer-stone	Ceramic	Mano	Metate	Indeterminate Ground Stone	Shell	Bone	Pestle	Tested Cobble	Feature
Debitage (n=1012)	1.0	0.96	1.0	1.03	0.99	0.88	0.93	0.98	0.96	0.84	0.87	0	0.57	0.78
Flaked-Stone Tool (n=86)	0.96	1.0	0.99	1.01	0.96	0.97	0.94	0.99	0.91	0.75	0.74	0	0.65	0.83
Core (n=147)	1.0	0.99	1.0	1.04	0.98	0.93	0.93	0.99	0.95	0.079	0.81	0	0.64	0.84
Projectile Point (n=7)	1.03	1.01	1.04	1.0	1.06	0.99	0.97	1.0	1.02	0.77	0.89	0	0.70	1.02
Hammerstone (n=42)	0.99	0.96	0.98	1.06	1.0	0.88	1.01	0.99	0.91	0.87	0.88	0	0.52	0.75
Ceramic (n=57)	0.88	0.97	0.93	0.99	0.88	1.0	0.85	0.93	0.82	0.62	0.61	0	0.75	0.85
Mano (n=43)	0.93	0.94	0.93	0.97	1.01	0.85	1.0	0.96	0.84	0.88	0.84	0	0.44	0.66
Metate (n=60)	0.98	0.99	0.99	1.0	0.99	0.93	0.96	1.0	0.91	0.83	0.8	0	0.58	0.77
Indeterminate Ground Stone (n=128)	0.96	0.91	0.95	1.02	0.91	0.82	0.84	0.91	1.0	0.78	0.86	0	0.59	0.82
Shell (n=43)	0.84	0.75	0.79	0.77	0.87	0.62	0.88	0.83	0.78	1.0	0.89	0	0.31	0.49
Bone (n=94)	0.87	0.74	0.81	0.89	0.88	0.61	0.84	0.8	0.86	0.89	1.0	0	0.35	0.57
Pestle (n=1)	0	0	0	0	0	0	0	0	0	0	0	1.0	0	0
Tested Cobble (n=13)	0.57	0.65	0.64	0.70	0.52	0.75	0.44	0.58	0.59	0.31	0.35	0	1.0	0.87
Feature (n=40)	0.78	0.83	0.84	1.02	0.75	0.85	0.66	0.77	0.82	0.49	0.57	0	0.87	1.0

18.3 Assemblage Diversity: Flaked Stone

Current archaeological research into the organization of flaked-stone technology has yielded several intriguing insights into the relationship between raw material selection, core reduction strategies, and tool function (Odell 2004; Miller 2007; Tomka 2001; Vierra 2007). Raw material analysis for the Jornada Mogollon region, including the Laguna Plata basin, has shown a strong trend for the selection of locally available tool stone, as well as a general decrease in stone quality through time (Carmichael 1986; Mauldin 1986; Miller 2007; Whalen 1977). In turn, variability in material type, as defined by artifact assemblages, has been tentatively linked to modifications in lithic reduction strategies, shifts in mobility, and changes in subsistence patterns. Moreover, it can be argued that on a localized scale, the frequency of specific stone types within Archaic and Formative-aged assemblages is providing information about forager and collector site types rather than about stone selection and material procurement. While not viewed as a singular causal factor, tool stone selection may be symptomatic of broader socioeconomic and organization shifts within a region.

18.3.1.1 Raw Material Selection and Environmental Stress

Haskell (1997) and Laumbach et al. (1979) have suggested that the alluvial fans and arroyos emptying into the Laguna Plata basin contain a diverse assortment of suitable tool stone, including chert and limestone/dolomite. Tool stone, including chalcedony, chert, obsidian, and quartzite, are also available as secondary river deposits within and adjacent to the basin (Haskell 1977). Despite an abundance of stone sources, knappable stone is not located congruently across the Laguna Plata landscape. Even within a specific outcrop, stone quality may differ substantially. This is observable along the southern portion of the site where sandstone outcrops are exposed. Therefore, acquiring the raw material appropriate for manufacturing stone tools must be predictable and occur in accessible sources. Among Archaic and Formative period populations, two stone procurement strategies may have been employed. The first strategy infers purposeful movement across the landscape with the goal of acquiring knappable stone. This direct procurement strategy may have played a significant part in accessing rock outcrops or secondary gravel deposits, but based on the diversity of materials identified at LA 5148, it seems that this strategy may have been rarely employed. The second strategy stands in contrast to the first, and suggests that hunter-gatherer groups balanced the need for tool stone with edible resource acquisition. This embedded strategy employed an encounter, or a ‘use what was immediately available’ approach to tool manufacture. These two strategies are not to be viewed as mutually exclusive, but as flexible options that shifted as needs changed through time.

18.3.1.2 Raw Material Distribution and Tool Stone Selection

Lithic artifacts documented during the TRC site survey and those collected by LCAS at C-10-C in 1971 were used in examining tool stone selection and are presented in Figures 18.4 and 18.5. Chert, representing a variety of textures and morphologies, was the most dominant material identified within the two assemblages, comprising 64.97 percent (n=820) and 44.01 percent (n=433) respectively. Quartzite was the second most abundant material comprising 10.69 percent (n=135) of the C-10-C locus assemblage and 44.19 percent (n=426) of the total Laguna Plata site surface flaked-stone artifact assemblage. Chalcedony exhibits elevated frequencies for the LCAS assemblage (12.91 percent/n=163) and lower frequencies for the TRC assemblage (2.28 percent/n=22). Rhyolite (2.45 percent/n=31), Limestone (2.45 percent/n=31), and igneous other (3.72 percent/n=47) represent the remaining material types collected from the C-10-C. Other materials collected by LCAS represent less than 1.0 percent of the flaked-stone assemblage at C-10-C and include: sandstone (0.54 percent/n=7), obsidian (0.23 percent/n=3), basalt (0.31 percent/n=4), hornfels (0.23 percent/n=3), orthoquartzite (0.63 percent/n=8), silicified wood (0.63 percent/n=8), siltstone (0.07 percent/n=1), and metamorphic stone (0.07 percent/n=1).

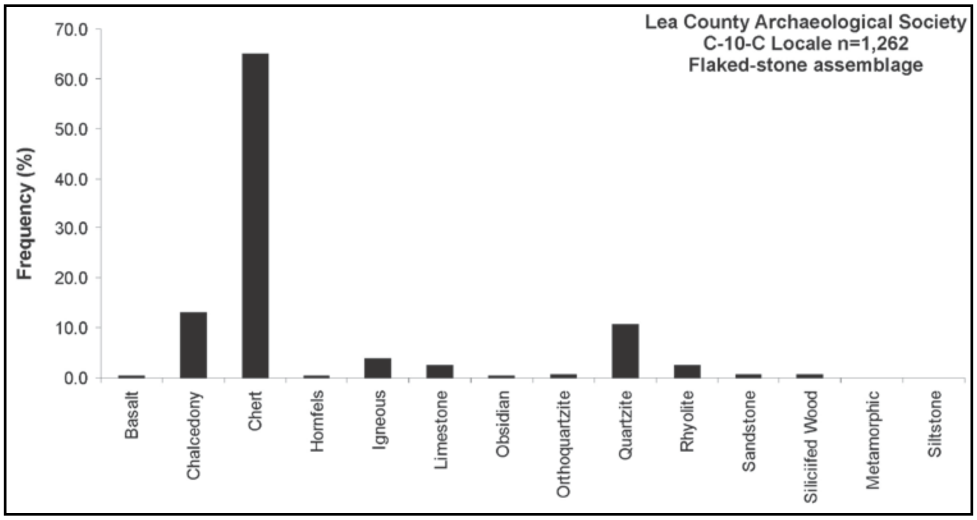

Figure 18.4 Raw material frequency distribution for the LA 5148, C-10-C locale (n=1,262)

For the TRC site survey data, basalt (3.42 percent/n=33), rhyolite (1.65 percent/1.65), and obsidian (1.14 percent/n=3) are considered materials of major importance. The remaining stone types represent less than 1.0 percent and include siltstone (0.20 percent/n=2), sandstone (0.31 percent/n=3), dolomite (0.31 percent/n=3), limestone (0.72 percent/n=7), and indeterminate stone (0.82 percent/n=8). It can be argued that material preference is determinate as to raw material availability within the playa environment; however, stone procurement and selection was probably dependent on a number of factors including abundance, availability, access, and suitability for intended tasks.

The combined distribution of raw material types selected for lithic debitage (n=1,949), ground stone artifacts (n=189), cores/tested cobbles (n=145), flaked-stone tools (n=126), hammerstones (n=47), and projectile points (n=80) are shown in Figure 18.6. For lithic debitage, the most frequent raw material was chert (56.84 percent/n=1,108), followed by quartzite (24.11 percent/n=470), and to a lesser extent chalcedony (8.92 percent/n=174) and igneous stone (2.30 percent /n=45). Basalt (1.79 percent/n=35), limestone (1.79 percent/n=35), and rhyolite (2.0 percent/n=39) comprise 5.58 percent of the lithic debitage assemblage. Nine other raw materials were identified in much smaller frequencies (2.17 percent/n=43). The main raw material identified for the flaked-stone tool assemblage, which includes utilized debitage and formal tools, parallels the debitage assemblage and shows chert (64.28 percent/n=81) is the main choice of selected material. Quartzite (19.04 percent/n=24) was the next highly favored choice of material. The next highest occurring materials were chalcedony (3.17 percent/n=4) and indeterminate material (3.17 percent/n=4). Limestone and orthoquartzite each comprise 2.38 percent (n=3) of the combined TRC survey and LCAS collection debitage data.

Projectile points (n=80) including one drill fragment were made from either chert (80.0 percent/n=64) or chalcedony (8.75 percent/n=7). Obsidian (3.75 percent/n=3) is also present, but in lower frequencies. Four other material types were recognized, individually comprising 1.25 percent (n=1) of the assemblage for a combined 5.0 percent of the assemblage. The distribution of other raw materials used for tool manufacture (core/tested cobbles and hammerstones) is relatively low (7.57 percent/n=192). For hammerstones (n=47), the most common raw material was quartzite (78.72 percent/n=37) followed by chert (6.38 percent/n=3) and rhyolite (4.25 percent/n=2). One-hundred forty five cores/tested cobbles were identified during the TRC survey and in the LCAS collection, the majority of which were quartzite (47.58 percent/n=69) and chert (40.0 percent/n=58). Other stone used for the production of cores/texted cobbles included chalcedony (4.82/n=7) and rhyolite (4.13 percent/n=6).

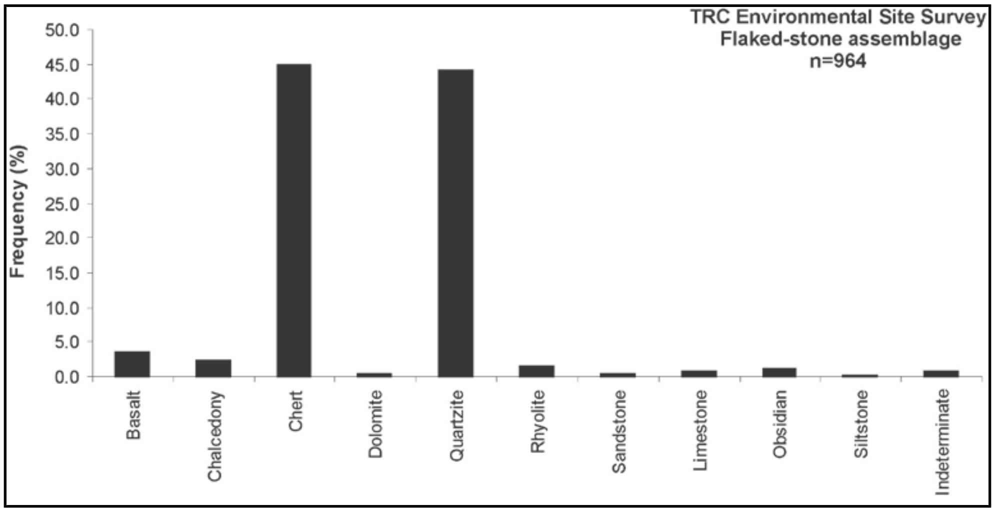

Figure 18.5 Raw material frequency distribution for the TRC survey at LA 5148 (n=964)

For the fabrication of ground stone implements, one material type stands out: sandstone (95.23 percent/n=180). This is not surprising since sandstone outcrops are clearly visibly and easily accessible at LA 5148. Quartzite (2.64 percent /n=5), granitic material (1.05 percent/n=2), basalt (0.52 percent/n=1) and limestone (0.52 percent/n=1) occurs less frequently.

18.3.1.2.1 *X-Ray Fluorescence: Obsidian Analysis*

To further identify material types at LA 5148, six obsidian specimens, three from the LCAS collection and three from the TRC survey, were submitted to the Archaeological XRF Fluorescence Spectrometry Laboratory, Cerrito, California, for non-destructive energy dispersive x-ray fluorescence (XRF) analysis. The samples were analyzed with a Thermo Scientific Quant'X EDXRF spectrometer and matched with existing trace element dart sets from known obsidian flows. The element characterizations are presented in Appendix G.

The six artifacts were sourced to one of three obsidian flows associated with the Valles Caldera in the Jemez Mountains of New Mexico: 1) El Rechuelos, 2) Cerro Toledo Rhyolite, and 3) Valles Rhyolite (Shackley 2005). Of the three, only Cerro Toledo Rhyolite and Valles Rhyolite are considered here (see Appendix G). Of the six samples, only one (Specimen 11) is associated with the Valles Rhyolite source which is available throughout portions of the San Antonio Creek alluvium (Shackley 2005).This source area is along the northern margin of the Valles Caldera. It occurs in cobble form (~15 cm in diameter), and is relatively scarce in comparison to Cerro Toledo Rhyolite. Specimens 16, 32, 48, 113, and 260 are sourced as Cerro Telodo Rhyolite, which occurs along the northeast and southern edges of the Valles Caldera. Shackley (2005) suggest this form of obsidian is more abundant and easily obtainable, but varies in quality and ranges in size between 10 and 20 cm in diameter.

Although obsidian nodules are available within the Jornada Mogollon region, most notably in the Rio Grande terraces, the prospect of availability in the Laguna Plata basin is more challenging. While obsidian does occur in the Pecos River terraces and at prehistoric sites in the region, the density of obsidian artifacts is limited (Condon et al. 2008b). This interpretation is supported by the general lack of obsidian observed and collected at LA 5148.

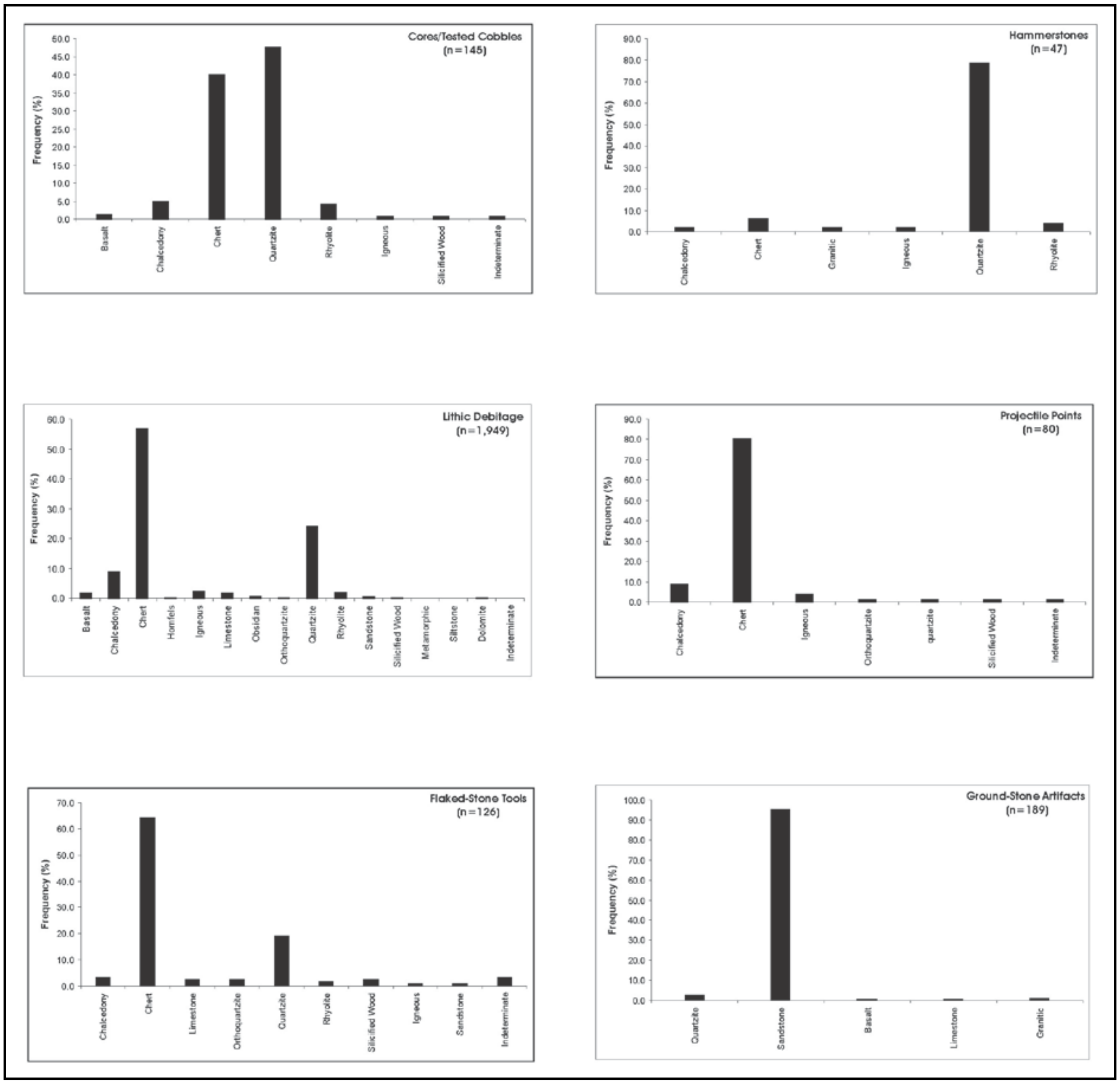

Figure 18.6 Raw material frequency distributions for cores, hammerstones, lithic debitage, projectile points, flaked-stone tools, and ground stones artifacts

18.3.1.3 Summary

In summary, the ubiquitous preference for chert and quartzite across the entire assemblage is the result of availability and occurrence of the Ogallala formation associated with the caprock margin of the Southern High Plains (Haskell 1977; Holliday 1997b). While other materials are used, their occurrences might be limited to several factors, including access, quality, and functional response to environmental needs. The preference for coarse-grained material types such as basalt and quartzite may preclude the need for fine-grained tool stone that produces a finer cutting edge. Moreover, the low occurrence of rhyolite may support the premise of an embedded collection strategy that primarily relied on raw material that is nearby or can be acquired opportunistically during the course of other activities. The obsidian sourcing data presents one tentative exception to this interpretation. It is unclear whether obsidian found its way to LA 5148 through trade and exchange or as the result of a chance find. Concurrent with this premise is the interpretation that no obvious trading networks or extensive contact with populations outside of the region existed with regard to tool stone. This is in keeping with current models of prehistoric land use for the region, that suggest stone was procured from local gravel sources and accessible out crops as secondary events.

18.4 Organization of Technology: Features

Features are traditionally viewed as unmovable material reflections of human behavior and for the purposes of this project are used as one method to define site activity (Condon et al. 2007, 2008b). In this section, features were evaluated by form and functional elements associated with resource processing, secondary artifact deposits, and with architecture. These three feature classes addressed the technological facilities identified during survey and testing.

Miller and Kenmotsu (2004) provide a cumulative frequency graph correlating radiocarbon distributions and feature types across the Jornada Mogollon region between A.D. 200 and 1600 (Figure 18.7). The distribution pattern shows a prominent trend in the use frequency of small burned-rock features and small hearth features (i.e., pits with an absence of thermal rock) prior to A.D. 1000. An increase in rock-lined features and trash/storage features is noted for the same region post-A.D. 800. Medium and large burned-rock feature frequencies display an undulating pattern of peaks and valleys up to A.D. 1200, after which a definitive decline in the frequency of these feature types is observed for west Texas and southern New Mexico (Miller and Kenmotsu 2004:252).

Hearths and roasting pits, which may require a pit to be excavated in order to successfully accomplish the processing task, present several scenarios illustrating different models of feature construction. Although several common denominators co-occur in almost every example provided by the authors, the necessity for correct height-depth dimension is as significant an attribute as whether thermally conductive stone is layered below or above the resource to be processed. In an archaeological context, pit morphology becomes critical if the most salient component of the feature, that is thermally altered rock, is removed from its principal location. As a result, archaeologists commonly encounter a loose scatter or moderate aggregation of burned-caliche cobbles in loose (or direct) association with a basin-shaped pit. The contextual integrity of the burned-rock has much to do with the rate of deflation and erosion present within a given environment. Site-formation processes also play a prominent role in the vertical deflation and infilling of the pit. However, the pit element is a static phenomenon whereas the lifecycle of the burned rock is dynamic. Of the two salient feature components, the morphology of the pit usually has the characteristics that were present immediately after construction, during the functional activity, and after abandonment (Condon et al. 2008b).

Features identified during TRC's testing at the Laguna Plata site were subjectively defined based initially on the presence or absence of two technological attributes, burned rock and/or a definable pit. The presence or absence of burned-caliche cobbles is self-explanatory. Characteristics of a pit included carbon-stained sediments with charcoal, ash, and oxidized soils. It should be noted that the presence and absence of a pit was based on a trowel test that determined depth below ground surface. In the presence of contextual integrity, these feature attributes were viewed as sufficient on a nominal scale of measurement to build inferential statements on the past use of LA 5148. Survey and testing at LA 5148 documented 43 features in which five feature types were identified.

Domestic features were typed as pit houses, hearths, burned-caliche cobble concentrations, or burned-caliche scatters (Condon et al. 2008a, 2008b; Hogan 2006). Two additional feature types were included in this study: artifact concentration and midden. Of the 43 features identified, two (4.65 percent) were typed as pit houses, three (6.97 percent) as burned-caliche concentrations, four (9.30 percent) as artifact concentrations, and eight (18.60 percent) as burned-caliche scatters. One (2.32 percent) feature was interpreted as an artifact midden. Hearths, however, occurred with the highest frequency. Hearths were defined as a subterranean pit with or without associated burned rock. Seven (28.0 percent) hearths are carbon stains with no burned rock. The remaining 18 (72.0 percent) hearths exhibit a variety of dimensions but all contained carbon-stained sediments with depth and burned-caliche cobbles. Interestingly, 20 (80.0 percent) hearths also contained associated ground stone. Eleven (44.0 percent) hearths included small calcined or burned-bone fragments. Many of these hearths are also interspersed among larger artifact concentrations, particularly common in the south half of the site. In a similar fashion, burned-caliche scatters most often were situated on paleosols surfaces along the ridge margins where deflation and erosion were most accelerated. Due to the lack of contextual integrity, burned-caliche cobble scatters were difficult to interpret.

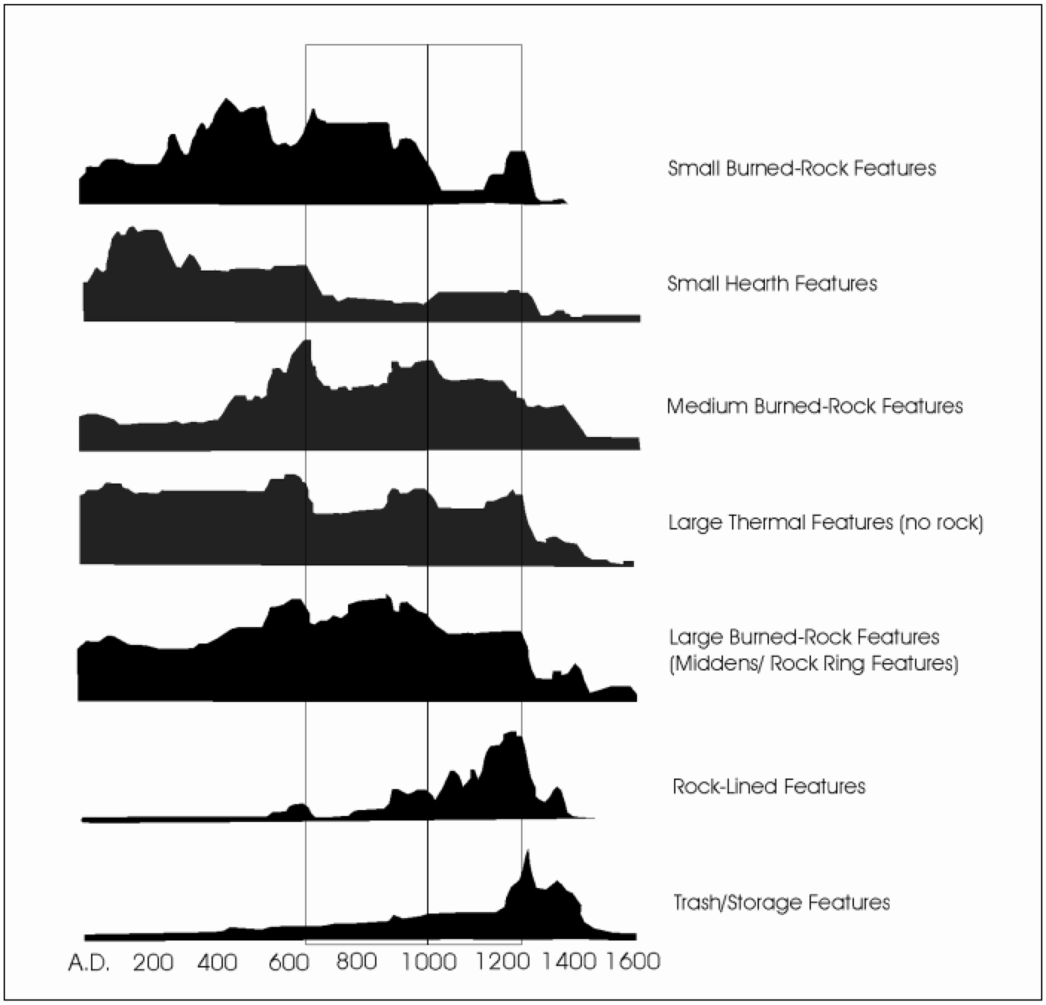

Figure 18.7 Radiocarbon probability distributions for feature categories across the western Trans-Pecos region between A.D. 200 and 1600

(modified from Miller and Kenmotsu 2004:252, Figure 7.31)

The most common feature type associated with the TRC survey and testing program consisted of thermal pits with burned-caliche cobbles. These feature types (n=18) averaged 2.20 m in diameter with Feature 7 (21.0 m) and Feature 9 (8.0 m) (Figure 18.8). When these two outliers are removed (n=16), the mean diameter is reduced to 66 cm. Hearths without burned-caliche cobbles (n=7) averaged 47 cm in diameter. Both these averages fall within an expected mean range of hearths in the region (< 1.0 m) (Condon et al. 2007, 2008b). However, comparing the LA 5148 hearth data (combined n=23) with samples documented at Bear Grass Draw (n=41) there are differences in mean diameter. Bear Grass Draw hearths average 1.25 m in diameter with a 1.03 m standard deviation. This suggests greater size and greater diversity in diameter when compared to the hearths (x=60 cm, sd=68 cm) at LA 5148. Diversity in size may reflect functional variation, degree of preservation, or differences in measurable attributes. The lack of burned-caliche cobbles may reflect specific functions that do not rely on burned rock and generally result in a smaller measurement. An alternative interpretation is that features with or without burned rock are functionally similar, but differ in that the burned rock had been removed prior to feature abandonment and are functionally similar to other domestic hearths.

There is a noticeable lack of storage features at LA 5148. This may be the result of the limited subsurface testing, but in general, the documented features do not appear to be storage related. This is not surprising as portable storage in the form of jars or baskets may have been more convenient amongst mobile populations. It should also be noted that quantifying storage pits is typically difficult if the morphology and internal characteristics of the pit do not conform to the traditional definition of a storage pit that is bell shaped or steep-sided with depth. Complicating matters is secondary use of the feature for functions other than storage. While not commonly identified at any of the residential sites, the secondary use of existing pits for food processing is a possibility that would obscure the initial storage function of the feature. Taking this into consideration, Feature 6 does retain attributes that suggest storage rather than a thermal function. The cross section of Feature 6 revealed steep, almost vertical walls, a general lack of burned-caliche, a lack of artifacts, and a homogenous matrix. However, the macrofloral analysis did not yield findings other than indeterminate wood charcoal and small *Prosopis* sp. (mesquite) fragments.

Finally, the number of discernible features at LA 5148 is such as to infer a moderate-to-high level of site use, repeatedly over time that involved both the processing of resources, the possible storage of resources (Feature 6), and the sheltering of the site inhabitants. The similarity in feature types suggests commonality in function that is more akin to small hearths rather than large processing features. The paucity of large processing features may relate to a scarcity of resources that would necessitate the processing of resources on a large scale. In contrast, LA 5148 has a large number of features, which may not correlate with any single period of site use, but may relate to occupation of the site over time. Finally, the large roasting pits, as defined by burned-rock middens, annular rock rings, and crescent middens of burned rock, are absent. Their absence may suggest processing of resources, such as agave, may not have been a focus at the site. More likely, the environmental conditions were not favorable to the flourishing of this resource and subsequently, it is not present in the archaeological record.

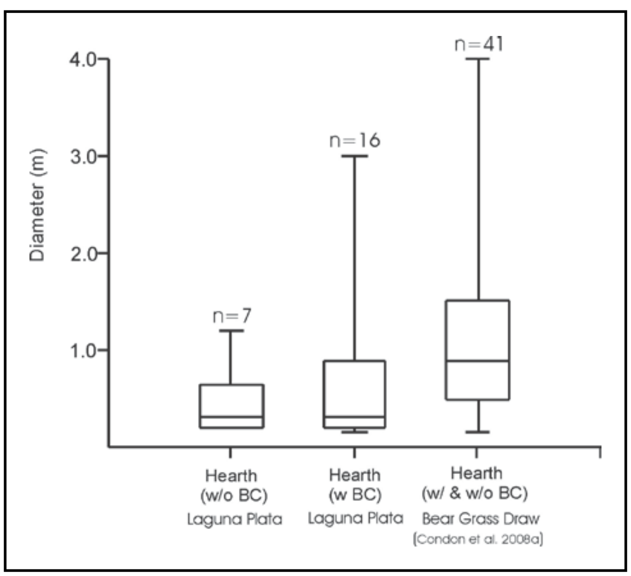

Figure 18.8 Box plot showing variation in hearth diameter and burned-caliche association

18.5 Subsistence and Settlement Patterns

An understanding of prehistoric economies that evolved locally in the Jornada Mogollon region is essential in determining the relationship between prehistoric cultures and the environment. For the Jornada Mogollon region, and in particular those populations occupying lands east of the Pecos River, resource specialization and plant domestication has been ephemerally identified, with horticulture a viable, but undefined, alternative to a foraging and collecting adaptation strategy by A.D. 1150/1200. Shifts in plant and animal utilization are broadly linked to changes in climate, most notable in precipitation. The measure of adaptation is found in the interaction between cultures and their environments, or cultural ecology.

The adaptive-dynamic approach to cultural ecology is defined as the coping mechanisms employed by a culture that allows for adjusting on both the social and environmental levels that facilitates a continuation of the culture. Those features that allow the cultural system to continue will be maintained while those less suited will be abandoned. Therefore, cultures are dynamic, when needs cannot be satisfied by one system, a subsystem is likely to originate through the adaptive actions of individuals or social groups (Bennett 1976:255). Changes in resource procurement can be viewed through two dynamic processes referred to as adaptive drift and adaptive selection.

Adaptive drift consists of the movement or decision making of a cultural system, in this case hunter-gatherer populations, in a certain direction due to the preservation of a cultural style or traditional precedent. Changes in subsistence are brought about by the interaction of factors such as the introduction or development of new technologies, changes in resource availability, seasonal shift in the quality of resources, and social responses to change (Church et al. 2009:8–11). As such, the initial factor in examining prehistoric subsistence involves identifying available resources and changes in the resources diachronically.

Adaptive selection refers to the development of a sustained yield system through a series of experiments with natural resources. Experimentation combined with particular behavioral styles is suited to the emerging techniques and culture change (Bennett 1976:294). On a regional level of interpretation, adaptive selection may be used to help understand the shift in emphasis from non-domesticated plants and animals to a subsistence strategy focused on cultivated plants. The economic orientation that emerged as a result of drift and selection during the Late Archaic and Formative periods was highly differentiated, consisting of more than one species exploited and more than one method for acquiring food. As such, acquiring food, whether it was plant or animal, was dependent on a series of variables including seasonal availability and relative importance in the diet. Adaptive selection and, ultimately, adaptive drift are hypothesized through the increased exploitation of medium to large animals after the introduction of the bow and arrow technology, the dominance of non-domesticated plants, selective access to cultigens, and the hunting of small animals, suggesting mobile hunter-gatherers on a seasonal basis continued to exploit certain productive ecosystems. The resulting analyses provide the datasets by which these models can be tested.

18.5.1 Palynological and Macrofloral Analysis

Chemical extraction of pollen samples was conducted at the Palynology Laboratory at Texas A&M University, using a procedure designed for semi-arid Southwestern sediments. The method, detailed in Appendix B, specifically avoids use of such reagents as nitric acid and bleach, which have been demonstrated experimentally to be destructive to pollen grains (Holloway 1981). Five pollen samples collected from Backhoe Trenches 1 and 6 were submitted for analysis. Backhoe Trench 1 was in Survey Parcel No.1, immediately north of the Laguna Plata site boundary. Backhoe Trench 6 was in Survey Parcel 4, along the southeastern margin of the playa basin. In addition, six macrofloral samples were submitted for species identification. Feature 2 consisted of a wood charcoal sample collected from the only remaining post identified in this shallow structure. Feature 3 yielded a macrofloral sample collected from Post C. Two samples from Feature 6 were submitted for analysis. Finally, Specimen 369, identified in the LCAS collection was submitted for species identification. Results of these analyses are summarized below, initiating with the palynological analysis and followed by the macrofloral analysis.

18.5.1.1 Backhoe Trench 1 (Pollen Samples 4 and 5)

Two soil samples were collected from Backhoe Trench 1. The pollen assemblage from this trench was poorly preserved and contained minimal pollen. Sample 4 contained 265 grains/gm total pollen concentration values. *Pinus edulis* (pine) type pollen (71 grains/gm) was present in trace amounts. *Poaceae* sp. (grass seed) and low spine *Asteraceae* (sunflower) (18 grains/gm each) were also present in very low amounts. *Chenopodium-Amaranth* (Goosefoot-Pigweed), indeterminate pollen, and an unknown tricolporate were present in amounts only slightly higher. Sample 5 was collected from below Sample 4 and contained no pollen. A single grain of *Artemisia* (sagebrush) (4.42 grains/gm) was observed in the low magnification scan of the slide. This was the only pollen grain recovered.

18.5.1.2 Backhoe Trench 6

Backhoe Trench 6 contained three samples. Sample 1 contained a high concentration of pollen at 2551 grains/gm. This was also the only sample producing a pollen count in excess of 200 grains. *Pinus edulis* (pine) type pollen (162 grains/gm) was present in trace amounts only. *Juniperus* (juniper) and an unknown triporate grain (12 grains/gm) contained only single grains and were present in very small to trace amounts. *Ulmus* (elm) pollen (46 grains/gm) was present in low amounts. *Chenopodim-Amaranth* (Goosefoot-Pigweed) pollen (139 grains/g) counts were also low as were counts for *Poaceae* (grass seed) and pollen clumps of *Chenopodium* (Goosefoot) (23/gm). High spine (46 grains/gm), and low spine (81 grains/gm) *Asteraceae* (sunflower) were moderate to high, and *Artemisia* (sagebrush) (1881 grains/gm) was present in very high amounts. Small amounts of *Ephedra* (Mormon Tea) (35 grains/gm) and the unknown triporate (12 grains/gm) were also present. Interestingly, the pollen of *Fabaceae* (legume/bean) (46 grains/gm) was also present. These grains were somewhat larger and had a very pronounced exerted pore.

Sample 2 contained 5541 grains/gm and the highest pollen concentration value recovered from the site. *Pinus edulis* (pine) type (338 grains/gm) was present in very low amounts with low amounts of *Pinus ponderosa* (Ponderosa Pine) (135 grains/gm). *Juniperus* (juniper) (34 grains/gm), and *Quercus* sp. (oak) (68 grains/gm) were present in low to trace amounts. Cheno-am pollen (Goosefoot-Pigweed) (2635 grains/gm) dominated the assemblage along with high amounts (237 grains/gm) of *Poacea* (grass seed), high spine *Asteraceae* (sunflower) (1216 grains/gm), and *Artemisia* (sagebrush) (270 grains/gm). Only a small amount of low spine Asteraceae (sunflower) (68 grains/gm) was present. A moderate amount of *Ephedra* (Mormon Tea) (68 grains/gm) was present in addition to *Brassicaceae* (Mustard family) (68 grains/gm), *Fabaceae* (legumes/bean), *Eriogonum* (Wild Buckwheat), and *Sphaeralcea* (Desert Globemallow) (34 grains/gm each).

Sample 3 contained 212 grains/gm total pollen values and was based on a pollen sum of only 16 grains. *Pinus edulis* (pine) type pollen (27 grains/gm) was present in trace amounts only with very small amounts of *Chenopodium-amaranth* (Goosefoot-Pigweed) (119 grains/gm), *Poaceae* (grass seed) (13 grains/gm), low spine *Asteraceae* (sunflower) and *Artemisia* (sagebrush) (27 grains/gm each).

18.5.1.3 Palynological Discussion

The two samples collected from Backhoe Trench 1 were poorly preserved, with only Sample 4 yielding quantitative pollen counts. Species Pinus (pinus), Poaceae (grass seed), Chenopodium-amaranth (Goosefoot and Pigweed) and low spine Asteraceae (sunflower) were present; however, a pollen sum of only 15 grains was identified for these samples. In almost all cases, Pinus edulis (pine) type pollen was present in trace amounts and the pollen concentration values never exceeded low estimations. The consistently low pollen concentration values for this taxon suggest that it was deposited via long distance transport. The Pinus (pine) pollen identified at the Laguna Plata site is derived from higher elevation areas located to the northwest and southwest, and probably at some distance.

The assemblages from Backhoe Trench 6 were only slightly better preserved. Samples 1 and 2 contained pollen values of 2551 grains/gm and 5541 grains/gm, respectively. Sample 3 contained a pollen count of only 212 grains/gm. Sample 3 contained Pinus edulis (pine) type, Poaceae (grass seed), Cheno-am (Goosefoot-Pigweed), low spine Asteraceae (sunflower), and Artemisia (sagebrush). This is consistent with a desert scrub vegetation community as described for the Laguna Plata site. Sample 1, which contained the highest pollen sum, was dominated by Artemisia (sagebrush). While present in low pollen concentration values, the presence of Chenopodium-amaranth (Goosefoot-Pigweed), Poaceae (grass seed), and both high and low spine Asteraceae (sunflower), suggest the presence of a desert scrub floral component. The much higher Artemisia (sagebrush) component from this sample suggests a sagebrush component not recognized in the other poorly preserved assemblages.

Ulmus (elm) and Fabaceae (legume/bean) pollen were also present in Sample 1. Ulmus (elm) is not native to this area of New Mexico and the U.S.D.A. Plants Database (U.S.D.A. 2010) records no presence of Ulmus (elm) within Lea County, New Mexico, although it is present in adjacent Chavez and Eddy Counties, New Mexico. Species of Ulmus (elm) were introduced historically during the early part of the twentieth century as shade trees, and the pollen may have been deposited from several of the small communities outside of the project area. The pollen grains were in excellent shape and whatever their origin, are more modern in age. Fabaceae (legume/bean) pollen was also present and this was a rather large grain, with pronounced extended pores. While many members of the Fabaceae (legume/bean) look similar, this grain possessed several characteristics of the cultivated forms. While it cannot be stated with any degree of certainty that these grains belong to Phaseolus sp. (bean), it is interesting to speculate. The grains were also in excellent condition and it is possible that these represent modern deposition.

Sample 2 contained elevated frequencies of Cheno-am (Goosefoot-Pigweed), Poaceae (grass seed), Low spine Asteraceae (sunflower) pollen grains, and to a lesser extent, Artemisia (sagebrush). These species also argues for a desert scrub community. Given the pollen concentration values of these samples, sagebrush may be a more recent development in the area, or at least the dominance of this taxon.

Based on the identified pollen taxa, the question arises whether economic taxa are absent because they are truly not present, or, they are present in such small amounts to have been missed during sampling. In order to assess the likelihood of their being missed, the estimated maximum potential concentration values (Dean 1999) of target taxa was computed. Since the entire slide was examined (either by count or low magnification scan of the slide) the estimated number of marker grains per slide was computed by averaging the number of marker grains per transect and multiplied by the total number of transects examined. Assuming, that the first grain observed on a hypothetical second slide was one of the target taxa, the maximum potential concentration value can be computed. Thus, the number of the fossil grains is one, and the number of marker grains per slide is substituted for the number of marker grains counted in the pollen concentration formula. These data are presented in Appendix B-Table 2 and indicate the estimated potential pollen concentration values fall between 4.11 and 11.26 grains/gm. Without examining all of the pollen residues we can never be absolutely sure that target taxa are indeed absent from the assemblage. Given the low estimated potential pollen concentration values however, it is more likely that the missing taxa were indeed absent from these assemblages.

18.5.1.4 Macrofloral Results

Three feature samples collected from the Laguna Plata site were selected for macrofloral analysis. The feature samples were processed using the water separation-Flote-Tech flotation system. The initial volume of material was measured and recorded and then screened to remove the larger particles. The screened material was examined separately but was not subject to water separation. The light fraction was collected and dried separately. After drying completely, the material was placed in labeled zip-loc bags prior to analysis and submitted to Quaternary Service, Flagstaff, Arizona, for processing. In addition, a single floral specimen (Sample 369) was also submitted for species identification. All specimens were examined using a Meiji stereoscopic zoom microscope (7X by 45X magnification).

Wood charcoal specimens were examined using a modification of the snap method of Leney and Casteel (1975) in order to expose fresh transverse surfaces. This is necessary since soil particles often fill the vessel elements of the wood charcoal, obscuring the characteristics necessary for identification. Identifications of wood charcoal and seed materials were based on published reference materials (Martin and Barkley 1961; Montgomery 1977; Panshin and DeZeeuw 1980; Schopmeyer 1974), as well as comparisons with modern reference specimens. The summary results of the flotation samples are presented in Appendix B-Table 1. The individual results are summarized below by feature.

18.5.1.4.1 *Feature 2-Pit House*

Specimen 21 was collected from the lone remaining post identified on the floor of this shallow pit house. Approximately 10.0 mls of material was recovered, with a portion submitted for radiocarbon analysis. The analysis yielded indeterminate wood charcoal fragments along with *Prosopis* sp. (mesquite) charcoal. A single charred grass stem was also recovered as well as uncharred plant debris.

18.5.1.4.2 *Feature 3-Pit House*

Specimen 18 was collected from Post C along the northern boundary of the pit house. Approximately 3.0 mls of material was recovered, with a portion submitted for radiocarbon analysis. The macrofloral analysis identified indeterminate wood charcoal fragments along with *Prosopis* sp. (mesquite) charcoal.

18.5.1.4.3 *Feature 6*

Two light fractions samples were collected from Feature 6 and submitted for analysis. Specimen 49-1 was recovered from the base of Feature 6 and yielded indeterminate wood charcoal fragments in addition to *Prosopis* sp. (mesquite) wood charcoal. Specimen 49-2 was collected from the overlying A/B-anthrosol soil horizon of Feature 6. The analysis yielded indeterminate wood charcoal fragments along with *Prosopis* sp. (mesquite) charcoal. Uncharred plant debris, insect remains, and snail shells were also present.

18.5.1.4.4 *Specimen 369*

Specimen 369, originally believed to be a seed, was collected from Unit 6S/3E-G of the LCAS excavations (Figure 18.9). However, microscopic examination indicated this specimen is likely not a seed. Based on the internal anatomy of the object, this item resembles a type of shelf-fungus common in the area.

18.5.1.5 Macrofloral Discussion

The flotation remains were fairly small, yet consistent. Most of the wood charcoal consisted of small fragments that were too small for a positive identification; those that were identified consisted of *Prosopis* sp. (mesquite). Mesquite is consistent with the modern vegetation and was present, to a lesser degree, during site occupation. A single charred grass stem was recovered from the pit house floor (Feature 2). This may have been used as fuel or in construction of the pit house, but with only a single sample recovered any interpretation is speculative.

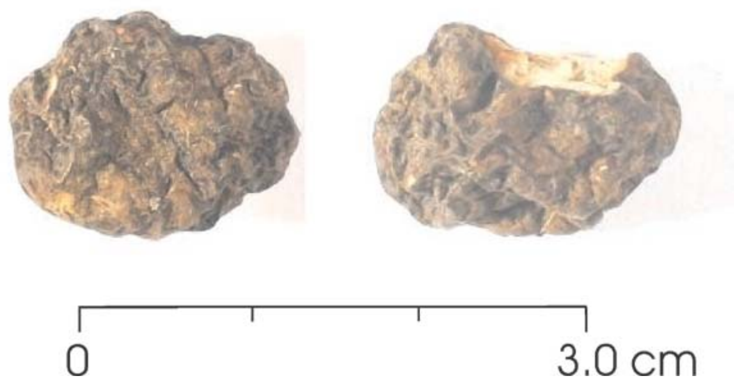

Figure 18.9 Specimen 369 showing two views of fungus

18.6 Starch Grain Analysis

Three artifacts selected from the LCAS collection and four recovered during the current TRC testing project were analyzed for starch grain residue. The seven artifacts, including three ground stone items and four pottery sherds, were submitted to the Foundation for Archaeobotanical Research in Microfossils, Fairfax, Virginia for starch grain analysis (Table 18.3). The analysis process first involved washing the artifact surface with reverse-osmosis filtered water and collecting the residuals. This process was repeated and the effluent settled. The settled medium was then centrifuged for ten minutes at 1000 revolutions per minute to pellet out solids, which were subjected to a heavy liquid flotation using Cesium chloride (CsCl) at a density of 1.80 g/cm3 to separate starch grains from the surrounding sediment matrix. This process was repeated three additional times. The remaining starches were placed onto a glass slide using a water/glycerin solution and scanned with a Zeiss Axio Imager A1 compound light microscope at 200 X using cross-polarized light microscopy. Identifications were made at the 400X magnification. The results yielded more than 301 starch grains or granules from the analyzed samples.

Table 18.3 Starch remains recovered from samples from the Laguna Plata site (LA 5148)

Sample #	Provenience	Artifact Type	Zea mays	Lenticular Type 1	Lenticular Type 2	Unidentified	Damaged
6	TU2 F3	Ground Stone		2			Grinding
47	Surface	Ground Stone			6		Grinding
50	Surface	Ground Stone			2		Heating
221	12S 2E-Z	Ceramic-Chupadero Black-on-white			2		Heating
229	N/A	Ceramic- Jornada Brown	2	1			Heating
517	6S 3W-A	Ceramic- Lincoln Red-on-black		9			Heating
662	B2	Ceramic- South Pecos Brown	3	14		1	Heat/Grinding
Totals		**7**	**5**	**26**	**10**	**1**	**42**

Of the seven samples, four yielded positive identification for non-domesticated lenticular starch grains indicative of *Elymus salinus* (wild rye) and three showed evidence of *Hordeum pusillum* (little barley). Two samples yielded *Zea mays* (maize) grains and one contained indeterminate starch grain residue. Two samples exhibited alteration or modification to the grains suggestive of grinding, four-exhibited gelatinization suggestive of exposure to heat and water, and one specimen produced evidence for both grinding and heat exposure. There are at least two types of grasses being used as food in addition to maize, and both were grains that were being processed into flour or meal and cooked in ceramic vessels on the site.

18.6.1 Conclusions

The starch residues provide solid evidence that the ground stone implements were used for grinding grain, and the ceramic vessels were cooking implements. Maize was present as were two different grasses that are probably wild rye and possibly little barley. The overall patterning of the starch analyses indicates what may be local production and gathering in addition to trade. There are three “categories” of remains: 1) the single occurrence of Lenticular Type 1 on two artifacts; 2) the combination of Lenticular Type 1 and maize on two artifacts; and 3) Lenticular Type 2 alone on three artifacts. Maize does not occur on any of the grinding implements, but is present in cooking vessels, while both lenticular starches are on each type of tool. It is noteworthy that maize only occurs with Lenticular Type 1 and not Type 2. At present, no solid explanation is available as to why the remains occur in this pattern. There may be at least two, and possibly three, distinct foodstuffs, one or more of which may be part of a distinct temporal and/or spatial context.

Because of the small sample size it is difficult to interpret what these patterns indicate in terms of which plants may have been collected from wild stands around the site, which may have been obtained through trade, and which may have been cultivated on site. An absence of maize on the ground stone implements may indicate its introduction into the site through trade, however, with only a small sample tested, no definite conclusions can be drawn. Future research should include a greater variety of artifacts from different spatial and temporal contexts so that a clearer understanding of the distributions of the different starch grains can be obtained.

Figure 18.10 The scale bar indicates 20 microns. All images are at identical magnification.

A) lenticular Type 1 from ground stone Specimen No. 6, B) lenticular Type 2 from ground stone artifact Specimen No. 47, C) lenticular starch with grinding damage from ground stone tool, Specimen No. 47, and D) maize starch from ceramic sherd, Specimen No. 662.

18.7 Fourier Transform Infrared Spectroscopy (FTIR) Residue Analysis

A combination of six samples from the LCAS collection and the current testing project assemblage were submitted to PaleoResearch Institute for FTIR residue analysis. In addition, one test sample (Specimen 52), a quartzite slab ground with raw pumpkin seed (*Cucurbita* sp.) was also submitted as a blind test. The results of these analyses are summarized below and in complete form in Appendix F.

18.7.1 Ground Stone Artifacts (Specimens 6, 50, and 52)

Organic residue analysis of a ground stone fragment from Feature 3 (Specimen 6) yielded peaks representing major categories (functional groups) of compounds in the 4000–1500 wave number range of the spectrum, as well as specific compounds noted in the fingerprint region (1500–400 wave numbers) of the spectrum. The functional group peaks indicate the presence of absorbed water and fats/oils/lipids and/or plant waxes. Peaks within the fingerprint region represent the presence of aromatic rings; aromatic esters; proteins including nucleic acids; the amino acid lysine; calcium carbonate; cellulose and carbohydrates; and polysaccharides including arabinose, glucomannan, and galactoglucomannan. Matches with these peaks were made with calcium carbonate and deteriorated cellulose indicating the sample is dominated by an environmental signal.

Peaks representing calcium carbonate and arabinose, a polysaccharide, are located very close to one another at 873 wave numbers. If this peak represents arabinose, a polysaccharide found in maize, it suggests possible processing of this cultigen with the ground stone. If, on the other hand, it represents calcium carbonate, then there is no secure evidence for processing maize at this location. Peaks representing the amino acid lysine suggest the presence of legumes, gourd/squash, and/or meat in the sample, and might suggest processing any or all of these foods.

Two ground stones from the site surface were sampled (Specimen 50 and 52) for organic residues. Sample 50 yielded functional group peaks indicating the presence of absorbed water and fats/oils/lipids and/or plant waxes. Peaks in the fingerprint region represent aromatic rings; aromatic esters; protein; the amino acid lysine; pectin; calcium carbonate; and polysaccharides including arabinose, glucomannan, and galactoglucomannan. This signal was matched with calcium carbonate and deteriorated cellulose. These matches suggest the presence of a strong environmental signal.

Specimen 52 (the blind test sample), yielded peaks representing functional group compounds including absorbed water and fats/oils/lipids and/or plant waxes. Other peaks identified in the fingerprint range indicate the presence of aromatic and saturated esters; protein; the amino acid lysine; pectin; calcium carbonate; calcium oxalates; humates; starch; cellulose and carbohydrates; and polysaccharides including arabinose, arabinoglucuronoxylan, glucomannan, and galactoglucomannan.

The signal representing this ground stone matched with raw *Agave* leaf pulp, baked *Agave* leaf skin, *Atriplex* (saltbush) fruit, baked *Cylindropuntia* (cholla) buds, *Quercus* (acorn) nutmeat, and grass seeds suggesting agave, saltbush, cholla cactus, acorn, and grass were ground with this tool.

Peaks indicating calcium oxalates in the sample support processing of agave, saltbush, and/or cholla cactus, and perhaps other locally available plants containing these crystals including *Yucca* and other members of the Cactaceae (cactus family) and Chenopodiaceae (goosefoot family). The possibility that calcium oxalates are present and detectable might also reflect deterioration of plant matter from local vegetation that included these plants. Other matches also were made with dried, ground *Zea mays* (maize) kernels. These matches suggest maize processing with the ground stone. Maize processing also might be supported by the presence of the polysaccharide arabinose, which is commonly found in this cultigen.

Matches with calcium carbonate and deteriorated cellulose probably are part of the local environmental signal. Peaks indicating the polysaccharide arabinoglucuronoxylan, which is found in the cell walls of all softwoods and herbaceous plants (Sjostrom 1981), likely reflect a combination of cultural activities and environmental processes that occurred at the site.

18.7.2 Flaked Stone Tools (Specimens 38 and 42)

A uni-marginal lithic tool recovered from the surface was tested (Specimen 38) for organic residues. Specimen 38 yielded functional group peaks indicating the presence of amines and fats/oils/lipids and/or plant waxes. Peaks within the fingerprint range of the spectrum represent aromatic rings; aromatic esters; protein; the amino acids aspartate, lysine, and serine; pectin; humates; cellulose and carbohydrates; starch; and the polysaccharides arabinogalactorhamnoglycan and glucan. Matches with this signature were made with Creosote (*Larrea tridentata*) leaves, twigs, and seeds. These matches probably reflect plants growing in the local environment, and not cultural utilization.

Contributions to the signal from meat are indicated by peaks representing aspartate and serine. The presence of these amino acids in the sample might represent either natural decomposition of faunal remains or possibly animal processing. Peaks representing amines, which are produced by the breakdown of amino acids through plant and animal decomposition (Guch and Wayman 2007:176), probably are attributable to either the cultural or environmental signal (or both) of the sample, as these compounds are not unique to either natural processes or cultural activities.

Specimen 42 yielded peaks representing functional group compounds including amines and fats/oils/lipids and/or plant waxes. Other peaks in the fingerprint region indicate the presence of aromatic and saturated esters; protein; the amino acid lysine; humates; and the polysaccharides arabinoglucuronoxylan, glucomannan, and galactoglucomannan.

No good matches were made with the signal obtained from this lithic tool for any of the

references in the PaleoResearch and forensic libraries; however, matches with peaks in only the fats and lipids portion of the spectrum between 3000 and 2800 wave numbers suggest nonspecific plant and animal materials are contributing to this range. The only other significant peak visible in the sample was a high amplitude peak at 942 wave numbers representing the polysaccharide glucomannan. This compound suggests the sample is heavily influenced by the presence of woody and fibrous tissues from conifers and dicotyledons (dicots). These plants probably reflect the local vegetation, but might also indicate plants processed using this tool.

Contributions to the signal from conifers might further be supported by a small, low amplitude peak at 1109 wave numbers representing another polysaccharide galactoglucomman. The peak at 1109 wave numbers also indicates arabinoglucuronoxylan. This polysaccharide suggests the presence of softwoods and herbaceous plants in the sample. Again, the inability to assign this compound to a specific plant species suggests arabinoglucuronoxylan in the sample could be attributable to a combination of natural processes and cultural activities.

18.7.3 Ceramic Sherds (Specimens 206 and 580)

Organic residue analysis of a Jornada brown ceramic sherd (Specimen 206) yielded functional group peaks indicating the presence of absorbed water and fats/oils/lipids and/or plant waxes. Peaks within the fingerprint range of the spectrum representing aromatic and saturated esters; proteins including nucleic acids; the amino acids lysine and glutamate; pectin; humates; cellulose and carbohydrates also were noted. Matches with these peaks were made with *Cucurbita* (gourd/pumpkin/squash) flesh, *Quercus* sp.

(acorn) nutshells, and cooked rabbit suggesting acorns, gourd/pumpkin/squash, and meat were contained and/or processed in the ceramic vessel represented by this sherd.

Although a match is made with rabbit, it is interpreted at a general, rather than specific, level, meaning that although it appears the inhabitants of the site were processing meat, the particular species or types of animals that were being utilized cannot be identified. It should be noted, though, that due to the ubiquity of rabbits in the area, the probability that rabbits were hunted for food is high.

The matches with *Cucurbita* flesh from cultivated squash for this sample probably reflect the use of cultivated gourds, squash, and/or pumpkin rather than those of a wild variety. Overlay of the reference signatures for the cultivated and wild species reveals significant differences in peaks represented in the protein, pectin, cellulose, and carbohydrate portions of the spectrum.

A South Pecos ceramic sherd tested (Specimen 580) for organic residues yielded peaks representing functional group compounds including absorbed water and fats/oils/lipids and/or plant waxes. Peaks identified in the fingerprint region indicate the presence of aromatic and saturated esters; protein; pectin; the amino acids lysine and glutamate; humates; and the polysaccharide galactoglucomannan. No good matches were made from the signal obtained from the South Pecos ceramic sherd with references in the PaleoResearch or forensic libraries. Non-specific plants and animals were matched with the fats and lipids portion of the spectrum suggesting these materials are contributing to the peaks at this range.

A smaller, low amplitude peak indicating the amino acid glutamate also is visible in this ceramic sample. The presence of this compound might indicate meat was contained in the vessel despite the absence of matches with mammal references; however, given the relative size of this peak it is more likely attributable to the natural decay of faunal remains in the sediments from which the sherd was recovered.

18.7.4 FTIR Discussion

The signatures from ground stone Specimens 6 and 50 exhibited strong environmental signals detecting calcium carbonate and deteriorated cellulose in the sediments. The presence of cellulose in the samples also could suggest processing of plants that have deteriorated to the point they are visible only by their general cellulose signature. It is likely that pollen and starch analysis would provide more information concerning use of these ground stones.

The FTIR record for the flaked stone tools (Specimens 38 and 40) yielded evidence of only an environmental signal. The uni-marginal tool (Specimen 38) matched directly with creosote, while Specimen 40 returned no matches, and only peaks suggesting non-specific contributions from decomposing flora and fauna, likely derived from the local environment, and not cultural utilization.

Examination of the organic residues from the ceramic sherds suggests the vessel represented by Specimen 206, the Jornada Brown sherd, was used to contain and/or prepare acorn; cultivated gourd, pumpkin, and/or squash; and meat, probably from rabbits. No matches were made with the Specimen 580, representing the other ceramic sherd from the site. Peaks visible in the signature indicating specific amino acids and polysaccharides suggest contributions from unidentifiable plant and animal materials, probably reflecting the environmental signal.

Overall, the FTIR residue analysis returned minimal results, which may be attributable, in part, on the quality of the samples and the size of the sample group. Of the six samples directly associated with the Laguna Plata site, only the Jornada Brown sherd yielded information that contributed toward reconstructing the subsistence practices during the Formative period. On a broad setting, the processing of acorn, pumpkin/squash, and rabbit all correlate with available resources for the area, and in case of acorn and rabbit, are clearly identifiable in the immediate Laguna Plata region.

The signatures gleaned from Specimen 52, however, pose several questions regarding the accuracy of the FTIR technique in general. What was tested as a single analysis, with the primary resource being raw pumpkin seed residue, yielded a complex suite of species (i.e., agave, saltbush, cholla cactus, grass seeds, nuts, and maize), none of which identified *Cucurbita*. These results may simply be explained by cross contamination within the store-bought, commercially processed pumpkin seeds. Another explanation may be the species of commercialized pumpkin seed used in the experiment may not be present in the reference catalog at the PaleoResearch Institute. At worst, the results infer possible sample contamination or some other misinterpretation in the analysis process. TRC has sent a sample of the raw pumpkin seeds to PaleoResearch Institute for continuing analysis and possible further explanation. A single sample, however, should not dissuade the use of the FTIR technique as a contributory means of interpretation, but should serve as a cautionary note as we proceed with future evaluation of the technique.

18.8 Faunal Analysis

The archaeofaunal assemblage recovered by LCAS consists of 1810 specimens. Excavation damage is common and except for carpals, tarsals, and most metacarpals, metatarsals, and phalanges, the various elements are broken. In addition, the eroded or corroded condition of the bones has resulted in further fragmentation. Corrosion is indicative of burial in highly acidic soils, of root etching, and/or the presence of organic acids (e.g., urine) (Andrews 1990:19) and has obscured evidence of gnawing, butchering, and use. As a result, gnawing was only identified on 108 specimens (6.0 percent), of which 100 (92.6 percent) are rodent gnawed, seven exhibit carnivore gnawing, and one was gnawed by both. This incidence is low, given the presence of pocket gophers and woodrat. In addition, butchering marks were only observed on 18 specimens (1.0 percent) and three worked bones were identified, including two awls.

The LA 5148 faunal assemblage is indicative of a diffuse hunting strategy consisting of the procurement of both small game, particularly leporids, and larger game—deer, pronghorn, and bison. The presence of low and high meat value elements for each of these animals indicates all were available locally. The leporid, deer, pronghorn, and bison remains do not lend themselves to providing reliable information about seasonality of site occupation. Seasonality, therefore, is not discernible in the faunal assemblage.

The leporid index of 0.28 indicates jackrabbit was the primary small game. The artiodactyl index is 0.27, which is indicative of hunting that was more focused on the procurement of rabbits, but with artiodactyls also contributing to the diet. The most common artiodactyl is pronghorn but deer and bison are also present. The skeletal part representation data indicate, except for deer and bison, essentially the entire leporid and artiodactyl skeletons are represented, which is indicative of local procurement. The paucity of definite deer remains may have resulted from longer-distance hunting, suggesting the bones were subject to the “schlepp effect” (Perkins and Daly 1968), in which less desirable portions of a carcass are left at the kill site and the more valued portions are brought to the site. The paucity of bison and bison-size remains indicates bison were not necessarily killed at the site, but in the general vicinity.

Bison (n=3) and probable bison (n=8) remains were only recovered from Features 1 and 3, which are probably contemporaneous (Formative III–VI) and only three bison-size specimens were recovered from Feature 2, which dates to the Archaic IV. The paucity of bison and bison-size remains, therefore, suggests hunting did not focus on the procurement of bison. Bison were probably hunted opportunistically, as they were drawn to Laguna Plata. The presence of both low and high meat value elements suggests bison were procured nearby.

All of the artiodactyl long bones have been broken, probably for the extraction of marrow. This was probably one of the main reasons for the presence of bison long bone elements in the assemblage. There is no evidence, however, for the production of bone grease. No large piles of pulverized bone were reported or recovered. Although the trunk elements of rabbits, especially cottontail, are underrepresented, essentially the entire rabbit skeleton is represented among the remains. The trunk bones may have been pulverized and consumed with the meat. This would have made consumption of the torso easier, rather than having to pick out all of the little bones. In addition, baking or boiling small animals can soften bones such as cervical and thoracic vertebrae and ribs, allowing incidental consumption with the meat. The exhibited pattern, however, may have resulted from the use of ¼-inch screens. In any case, the site occupants were probably not experiencing food stress and did not need to maximize the food value of their meat resources.

18.9 Subsistence Discussion

Subsistence models, such as the one presented in Chapter 4, assume that populations living in a semiarid environment will use resource procuring strategies that will maximize their return in habitats that provide the broadest resource base available. When we look at heterogeneity of the Laguna Plata site, as opposed to the relative homogeneity of the environment away from the Laguna Plata basin, it is easy to envision the productivity of this playa and its attraction for mobile populations (Haskell 1977:320).

Jelinek (1967), Katz and Katz (1985), Speth (2004), and Wiseman (2003) have contributed to our understanding of regional subsistence, each providing insight into prehistoric landscape use in southeastern New Mexico. Within each of their models, the relationship between wild and domesticated plants, as well as the role of bison, in the realm of culture change is discussed. For the Sierra Blanca region and the Middle Pecos valley, a trend towards an increasing emphasis on medium-to-large mammals, including bison, is assigned for the Formative period (Driver 1985; Jelinek 1967). Maize recovered from Bloom Mound and the Henderson sites (Rocek and Speth 1984) tentatively suggests the contribution of a horticulturalist economy at these late Formative period sites. With regard to the role of bison hunting for the region, Speth and Parry (1980) suggest an alternative subsistence pattern that questions the abundance and predictability of bison acquisition during the Formative period. Wiseman's (1985 cf. from Sebastian and Larralde 1989:81) evidence from the Rocky Arroyo site indicates fish and mussels may have contributed to the diet of these inhabitants. Finally, for regions east of the Pecos River, and which directly relate to the Laguna Plata site, Sebastian and Larralde (1989:82) summarize previous models by Corley (1965), Leslie (1979), Stuart and Gauthier (1984), and Speth (1983) that outline a subsistence pattern that does not include agriculture or a dependence on domesticated foods. In fact, other elements indicative of sedentary land use, or at least short-term sedentism at any one locus, such as pit houses and surface room blocks, have been identified, yet the subsistence strategies suggest a mixed resource, hunting and gathering economy.

Despite the significant regional accomplishments, a clear understanding of the role that subsistence played in regional prehistory of southeastern New Mexico is lacking. Sebastian and Larralde (1989:82) and more recently, Miller and Kenmotsu (2004:247), succinctly present the crux of the problem:

> Observed changes in architectural complexity and formality, combined with the location of settlement in relation to hydrologically favorable topographic zones, have been taken as evidence of increasing agricultural dependence and reduced settlement mobility during the Formative period.
>
> While it can be logically surmised that agriculture played a greater role in regional subsistence economies during the late Formative period, than in preceding periods, the extent or proportion of agricultural production in the diet remains unclear.

While it is clear that subsistence patterns have a significant, even determinant, effect on human behavior especially in semiarid environments, it is unclear which attributes shape the procurement decisions of mobile populations inhabiting the project area. Using the data gleaned from the Laguna Plata testing project in relation to a model of cultural ecology, several inferences are developed to clarify this dilemma.

The macrofloral analysis identified *Prosopis* sp. (mesquite) as the probable species associated with the infrastructure of Features 2 and 3, and with the wood charcoal identified with Feature 6. Access to mesquite would have been facilitated in areas were water was accessible, in particular, arroyos or along the playa margins. While the macrobotanical evidence provided limited evidence of plant use through time, starch grain analysis provided a more refined data set. The presence of *Elymus salinus* (wild rye) points toward the targeting of specific non-domesticated seed-bearing plants. The identification of *Zea mays* (maize), and possibly *Hordeum pusillum* (little barley), raises more questions than answers. The data supports the processing of *Zea mays* (maize), as well as two distinct grass species at the site. While the processing of cultigens can be demonstrated, the origin of the resource is problematic. The presence of cultigens may be through trade, as inferred through the ceramic analysis, or possibly, through small plot farming at or near the Laguna Plata site. Currently, evidence for horticulture is absent at the Laguna Plata site.

The faunal assemblage provides the most robust data set towards interpreting subsistence at the Laguna Plata site. Eleven identified species, including reptiles, birds, and mammals of small, medium, and large varieties are identified in the assemblage. Table 14.1 provides the summary data for species ubiquity. When overall frequency is examined, small mammals occur with elevated frequency, with *Sylvilagus audubonii* (desert cottontail) and *Lepus californicus* (black-tailed jackrabbit) the primary species present. Diversity should be noted as *Cynomys ludovicianus* (black-tailed prairie dog), *Cratogeomys castanops* (yellow-faced pocket gopher), and *Neotoma* sp. (woodrat) were also identified, but in smaller numbers. Larger mammals, including *Odocoileus* sp. (deer) and *Antilocapra americana* (pronghorn) comprise a substantial portion of the assemblage providing evidence for the exploitation of a primary resource. *Bison bison* (bison), although identified, comprises a small part of the assemblage.

As discussed in Chapter 4, the diet-breadth model of optimal foraging is based on a the premise that resources that provide the greatest return with the lowest amount of effort will rank higher and be desired over resources that offer lower return rates or greater effort to acquire (Bettinger 1991; Madesen and Schmitt 1998). The correlating assumption suggests that humans make these decisions daily, whether consciously or subconsciously. The inclusion of lower-ranked resources is generally based on availability of one or more low ranked species in the absence of other higher-ranked resources. For example, in the absence of deer, rabbits or grasshoppers may be substituted to the list of desirable resources. The resulting dynamic is the shift from hunting large mammals to smaller mammals and plant and seed collecting. As plant domestication becomes a factor, adaptive selection allows populations to shift from seeds as the primary food source to harvested crops, as long as the net return does not fall below the critical threshold for survival. The increasing reliance on a cultigen offers control of a resource, but limits movement of a population. Diversity and the balancing factor are expressed through the availability of non-domesticated food sources. Using this reasoning, the ranking of resources identified during the current testing project should, with the paucity of cultigens, primarily include artiodactyls and lagomorphs as the leading ranked resources. Bison reflect the least dominant species of artiodactyls, which although returns a greater caloric intake, can be unpredictable. This unpredictability is suggested by the presence, but not predominance, at the Laguna Plata site. Table 18.4 summarizes the subsistence ranking according to net caloric intake/handling time.

When the primary resources identified at the Laguna Plata site are assessed, *Lepus californicus* (black-tailed jackrabbit) and *Sylvilagus audubonii* (desert cottontail) would be ranked high in order of availability, although artiodactyls would be taken when the opportunity was presented. Smaller mammals, as well as *Terrapene ornate* (Western box turtle), and *Colubridae* (colubrid snakes), may be more opportunistic rather than a primary staple of the inhabitants diet. Plant species, such as *Elymus salinus* (wild rye) appear to be higher ranked than other plant resources. For instance, *Porceae* (grass seed), although not identified in the analyses, was in all likelihood, available at Laguna Plata. *Prosopis* sp. (mesquite) in a similar fashion, was present, but in low quantities and in ambiguous context with regard to consumption. *Zea mays* (maize) provides a comparable caloric intake to wild rye, but was identified in very low quantities. The minimal presence of *Zea mays* (maize) may be accounted for by the small sample group processed for analysis, but more likely reflects an absence of horticulture at the Laguna Plata site.

Table 18.4 Post-encounter return rates for common resources in the Jornada Mogollon

Resource Species	Common Name	kcal/hour
Bison bison	bison	5,920–11,950
Odocoileus hemonius	deer	17,971–31,450
Antilocapra americana	pronghorn	15,725–31,450
Agave lechuguilla	lechuguilla	730
Lepus sp.	jackrabbit	8,983–15,400
Atriplex canescens	fourwing saltbush seeds	1,033–1200
Elymus salinus	rye grass seeds	921–1238
Oryzpsis hymenoides	Indian rice grass seeds	301–392
Chenopodium rhadinostachyum	goosefoot seeds	652
Helianthus annuus	sunflower seeds	467–504
Typha latifolia	cattail roots	128–267
Zea mays (one ear)	maize kernels	711–1,133
Prosopis sp.	mesquite pods	1,733 –2,522
Opuntia sp.	prickly pear cactus	2,175
Portulaca sp.	purslane seeds	3,049–3,910
Yucca sp	yucca seeds	3,900
Brassicaceae	mustard seed	1,307
Amsinckia	fiddleneck seed	3,049–3,910
Poaceae	grass seed	575
Atriplex/Sarcobatus	fourwing saltbush	1,033
Hordeum jubatum	Foxtail barley	138–273

Bettinger 1991; Dering et al. 2001; Kelly 1995; Bohrer 2006, Table 18.8.

The abundance of resources in the Laguna Plata site environment suggests the hunting of small mammals provided a consistent resource base, but opportunistic hunting of medium to large mammals also made an important contribution to the diet. Bison outweighs the value of any other hunted resource, with the exception of herd mammals, which can be acquired in large numbers during a single hunting event.

Seasonal availability is a primary factor in resource selection regardless of ranking. Resource stress does not seem to figure into the subsistence pattern at the Laguna Plata site, suggesting the environment was favorable with active springs supplying fresh water to the local flora and fauna. The procurement of readily available fauna and flora species in large enough quantities may have outweighed the advantages that a predictable, but unstable and tethered food source, such as maize, offered. Due to the availability of wild game and plant species, *Zea mays* (maize) may have been acquired through trade or transport. Horticulture may not have played a significant role in the overall subsistence strategy at the site. However, the off-site growing of cultigens in suitable environmental niches within the Laguna Plata playa environs is another feasible alternative.

The adaptive dynamic, hunter-gatherers of the late Archaic through Formative period, would have adjusted their resource selection and scheduling to meet the seasonally available resources. Climate and precipitation would have played a critical role in acquiring resources. During the summer rainy season, floral resources would be more abundant and use of the playa basin would have experienced its greatest activity. Artiodactyls would have provided a larger resource, but would have probably been infrequent and acquired opportunistically. Small game, such as cottontail and jackrabbit, were consistently available. Absent from the site is evidence of large-scale plant processing, storage, and horticulture, suggesting the transition from a mixed resource economy to a horticultural economy were gradual or did not occur. Adaptive drift is recognized through increased hunting of medium and large game after the introduction of bow and arrow technology. This is tentatively evidenced at the Laguna Plata site where artiodactyls may represent a critical component of the subsistence economy. Adaptive selection is generally absent, as expressed by the continuation of a hunting and gathering economy during the Formative period even though there was access to cultigens and horticulture. As a precaution, one should remember that much of the subsistence record recovered from the Laguna Plata site is from a mixed context within an anthrosol of which the entirety of the Formative period is collapsed within a meter of sediment. Therefore, only a broad interpretation of the subsistence economy can be developed diachronically. In conclusion, it is difficult to discern a change in subsistence from the late Archaic through the Formative periods, indicating a continuation of Archaic period resource selection and practices being carried out at the Laguna Plata site.

18.10 Settlement Patterns

This section addresses settlement strategies and group mobility as they specifically relate to LA 5148. Following the model presented in Chapter 4, and the research issues discussed in Chapter 5, Mobility patterns are not clearly defined for the Archaic period and saliently expressed for the Formative period. An argument can be made that due to generations of artifact collecting at this site, a clear picture of land use is an impossible task (Haskell 1977). It is believed that site use during the middle and late Archaic period mimics the Formative period land use strategies at the Laguna Plata site until at least A.D. 1300. This interpretation was presented in Stuart and Gauthier (1984:290) and later by Katz and Katz (1993:122), who stated:

> "There are striking similarities between the topographic situations of Formative period sites (n=1,379 sites with Formative period components recorded in ARMS database in 1993) with those of the preceding Archaic period. In both periods, more than half of the recorded sites are located in only four topographic situations. In the Formative period, 65 percent of the sites are located in blowouts and dunes, and on ridges or benches. The first three situations are shared with Archaic sites; the Archaic preference for hill slope is shifted slightly to a Formative preference for benches".

An interpretation of group settlement and mobility is structured around Hard's (1983, 1986, 1990) and Mauldin's (1983, 1986) biseasonal models for the Formative period, which can be extended back to include the Late Archaic. This model suggests that shifts in settlement can be viewed as cultural adjustments or adaptations to seasonally related environmental conditions. Hard (1983), Mauldin (1986), Miller and Kenmotsu (2004), Kenmotsu et al. (2008), and more recently Condon et al. (2008b, 2010a, 2010b) have argued that diachronic shifts in settlement during the late Archaic and Formative period (A.D. 200/400–1450) are in part a result of seasonal variability and related changes in resource congruence within the region.

Seasonal variance for the Jornada Mogollon region is accentuated by severe drought conditions lasting from A.D. 940–1040 followed by above average rainfall between A.D. 1040 and 1125. Between A.D. 1125 and 1140/50 and A.D. 1205–1305 below average rainfall again characterized the region. From A.D. 1300–approximately A.D. 1400 the project area experienced increasing above average precipitation levels, suggesting that a period of resource abundance existed during this time span (Grisino-Mayer et al. 1997). These trends in precipitation support the concept of a highly adaptive populations that practiced a land-use strategy that was in large part influenced by environmental conditions, rather than population pressure or socio-complexity. Moreover, climatic variation may act as a critical factor instigating the movement of populations along a continuum of high mobility and short-term sedentism, always accentuated by logistical forays. This interpretation is presented in spite of population aggregation and agricultural reliance identified throughout much of the Southwest during the Formative period.

Adaptive strategies, which subsume seasonal adjustments, become more salient during periods of increased stress or during periods of increased abundance. Thus, the construct of adaptation is the process by which populations maintain homeostasis through responsive changes in their states, structures, or compositions in the face of both short-term and long-term environmental fluctuations (Rappaport 1971). This shift is further substantiated through an analysis of architecture and subsistence. As previously noted, significant differences in structure size exists between circular or oval-shaped pit houses within the greater Jornada Mogollon region (Condon and Hermann 2008; Gilman 1991; Hard 1983). Pit houses found along the alluvial fans markedly differ from those identified in the valley and basin low lands. There appears to be a difference in terms of invested labor when basin structures are compared to structures found on upland settings. This pattern may have relevance to southeastern New Mexico, where Speth and LeDuc (2007:45) suggest architectural variability may be the product of differing ethnicity or perhaps seasonality.

Settlement strategies for east of the Pecos River follows a continuum of seasonally influenced land-use patterns, characterized primarily by mobility rather than sedentism and a broad-based resource focus rather than a growing reliance on agriculture. Zamora's (2000) excavations at Macho Dunes and Wiseman's (2002) research at The Fox Place site both indicate group mobility and a mixed–resource economy. In a similar scenario to LA 5148, Zamora (2000:38) dates three ephemeral pit houses between A.D. 665 and 885. The Laguna Plata site pit houses are similar in size and morphology to the Macho Dunes structures, but lack the internal hearth or additional floor features identified by Zamora (2000:31). Structures at both sites lack depth and labor investment, with the Laguna Plata structures exhibiting shallow depressions and no clear indication of subsurface excavation to create walls or substantial support systems for structure infrastructure. Wiseman (2010, personal communication) tends to question the validity in applying the term pit house to the Laguna Plata site structures. As no formal subsurface infrastructure was identified within the two Laguna Plata site structures, Wiseman (2010, personal communication) is technically correct. A more applicable term is brush hut or ephemeral structure, however, a depression is present in Features 2 and 3 and for the purpose of this project, structures at the Laguna Plata site will be referred to as ephemeral pit houses. A comparative interpretation would be Whalen's (1994:139) Class 2/3 site type at the Turquoise Ridge site in El Paso County, Texas, which is characterized by small, shallow pit houses. The Keystone Dam site (EPCM 2:33), a late Archaic habitation site in El Paso County, Texas also revealed similar ephemeral pit house configurations (O'Laughlin 1980). In comparison, these sites differ in many aspects, but have at least one characteristic in common, limited duration occupation.

Wiseman (2002:25) excavated 11 of 13 pit houses at The Fox Place site, which all date much later: A.D. 1270–1315, A.D. 1345–1390, and A.D. 1410–1420. Unlike architecture in the Rio Grande valley, the morphology and general structural elements appear to remain somewhat static over the course of the Formative period. This suggests consistency in land use, mobility, and possible group size despite shifts in technology and social structure in areas surrounding the eastern margins of the Jornada Mogollon region. Exceptions are generally rare, but may be reflected at the Henderson and Bloom Mound sites were short-term sedentism seems to have taken hold. Despite a more established social organization and architectural intensification at these two sites, which date between A.D. 1250 and 1400 (Speth and LeDuc 2007:45), most residential sites in the Rowell and Carlsbad area appear less labor intensive and of short term duration. As suggested by Wiseman (2003) and Speth and LeDuc (2007), the causal factors surrounding the shift in architecture from pit houses to room block may be difficult to identify as no single factor may be to blame. At present, settlement patterns for southeastern New Mexico appear to be nonlinear, with many settlement characteristics transgressing time, with minor shifts occurring in response to resource availability, changing climate, and possibly, developing territorialism and encroachment from the east (Speth and LeDuc 2007).

Land use studies for southeastern New Mexico have identified adaptive strategies that are dynamic and variable within a diverse, and at times, marginal environment (Condon et al. 2008b; Railey et al. 2009; Speth and LeDuc 2007; Wiseman 2003). As such, the archaeological record with the eastern extension of the Jornada Mogollon is highly variable, but has a distinct signature unlike other portions of Lehmer's (1948) Jornada Mogollon region. There is interaction and similarities between regions, however, Corley's (1970) proposed extension of the Jornada Mogollon 150 miles eastward to encompass southeastern New Mexico south and east of Roswell, New Mexico may have been premature. As additional data becomes available, this area exhibits attributes that are consistent for areas east of the Pecos and do not parallel the traditional Jornada Mogollon region as defined by Lehmer (1948). Based on the current data, settlement patterns and land use studies indicate a highly mobile, mixed-resource economy that did not embrace horticulture or long-term sedentism, although, in all likelihood, recognizing both innovations.

18.10.1 Settlement and Land Use Patterns at LA 5148

Occupations at LA 5148 appear to reflect a continuation of adaptation that transitions from the Archaic period well into the Formative period, with innovative technologies, specifically, the bow and arrow, ceramics production, and plant domestication, displaying differential spatial and temporal utilization. This transition suggest an extended sequence of similar adaptations east of the Pecos River valley that continue relatively unaltered until at least A.D. 1400/1450. The current suite of subsistence data collected from LA 5148, identifies the use of wild rye (*Elymus* sp.), little barley (*Hordeum pusillum*), and to a lesser extent maize (*Zea mays*). Faunal analysis provides a more definitive view into exploited resources, as the western box turtle (*Terrapene ornate*), desert cottontail (*Sylvilagus audubonii*), black-tailed jackrabbit (*Lepus californicus*), deer (*Odocoileus* sp.), pronghorn (*Antilocapra americana*), and bison (*Bison bison*) were all present at the site. This mixture of resources indicates an environment that is diverse and able to support a multitude of species. In addition, the multiple habitats identified with the Laguna Plata basin supports an interpretations of resource congruence, where multiple resources are predictable and accessible to human populations. Accessibility to potable water afforded by the presence of spring vents along the southeastern margins of the basin provided this much-needed resource for all other resources and an added attraction to the inhabitants of the site. Within the broader settlement scope, the Laguna Plata locale may represent a multi-component residential base camp from which logistical diurnal activities, such as resource procurement, could be anchored. This interpretation suggests the Laguna Plata site was occupied through time on a seasonal or discontinuous schedule. The number of small-hearth features, and an absence of large burned-rock middens, documented throughout the site attest to heavy domestic site use. Feature data compiled by Katz and Katz (1993:122) note that features across the region tend to be similar in form, regardless of ecozone, topography, and temporal affiliation. Based on the feature data, activities tend to be conducted outside of structures, suggesting a favorable climate and available resources. If this model is correct, then the primary occupations at Laguna Plata during the late Archaic and Formative periods may have benefitted from above average precipitation and a wide range of exploitable resources.

The period from 750 B.C.–A.D. 800 experienced a general increase in temperature, with the culmination of a severe warming trend occurring from A.D. 900–1200 (Condon et al. 2010a, 2010b; Grissino-Mayer et al. 1997; Prentiss and Chatters 2003). This "Little Climatic Optimum" of the Southwest experienced fluctuating periods of extreme precipitation and aridity. Four periods of drought and four corresponding periods of above-average rainfall were documented for southeastern New Mexico during this period. The periods of drought include A.D. 710–720, A.D. 940–1040, A.D. 1140–1190, and A.D. 1210–1230. The periods of above-average rainfall include A.D. 740–840, A.D. 900–920, A.D. 1060–1120, and A.D. 1320–

1330 (Church and Sale 2003:28; Grissino-Mayer et al. 1997:61). The chronometric data from Features 2 and 3 overlap periods of both above and below average rainfall. It is conceivable that LA 5148 may have acted as an oasis during periods of drought where inhabitants would have exploited a limited range of resources. During periods of above average rainfall, the basin would have offered a plethora of resources. The two ephemeral pit houses identified at the C-10-C locus do not have internal hearths or floor features. This suggests a warmer weather (e.g., spring or fall) association were activities were conducted outside the structure. The infrastructure of the two pit houses does not appear elaborate or constructed for an extended occupation. Information on the structure walls or supporting posts is absent, but the support structure may have been mesquite and brush. Deflation has precluded an accurate assessment of structure depth leaving only a shallow depression in the center of the pit house. Given these attributes, the construction of these structures involved little labor investment and were, in all likelihood, constructed and used during cool weather months, perhaps during fall or spring.

As noted in Haskell (1977) and corroborated in the current project, the availability of lithic resources within the basin can be correlated with site use. The high frequency of locally accessible tool stone within the lithic assemblage indicates the availability of suitable raw materials. In particular, chert, chalcedony, and quartzite for flaked-stone tools and sandstone for ground stone implements. Table 12.1 summarizes material type frequencies for the lithic assemblage, including cores and lithic debitage from the LCAS collection. An examination of the materials reveals a distribution of local stone types readily accessible from the arroyos and exposed banks of the Laguna Plata basin. The flaked-stone tool assemblage, including projectile points, further strengthens this interpretation. Subsequently, tool manufacturing and maintenance can be included in the range of site activities occurring at the site over time.

Haskell (1977:331) further describes the activities conducted at LA 5148 as including the processing of plants and the butchering of animals. These activities are linked through the faunal analysis, which identified the butchering of mammals, and starch grain analysis. The processing of maize, little barley, and possibly wild rye is expressed through starch grain grinding and gelatinization, suggesting the grinding and boiling of domesticated and nondomesticated plant species. Skeletal elements of medium-to-larger mammals suggests an opportunistic hunting strategy when large game were attracted to Laguna Plata. Fall access to seed producing plants may have supplemented animal procurement. Animal procurement during the early spring may offset a decrease in accessible plant species. Cottontails and jackrabbits can be attained year-round. Water availability in a semi-arid environment is the single most critical factor attracting both humans and animals to a locale. LA 5148 is no exception to the rule, and in fact, may have provided reliable access to spring water and subsequently to plants and animals. The cumulative effect of these characteristics may have been a determining factor in the choice of settlement location.

18.10.2 Summary

Based on the testing data LA 5148 may have served as a residential site or base camp during the Archaic and Formative period. The re-occupation and density of the artifact assemblage attests to the importance of this site locale to regional hunter-gatherer groups. The construction of ephemeral pit houses suggests temporary extended site use, perhaps during colder months of the year, such as spring or fall. The location of LA 5148 on the landscape appears to have considered a combination of suitable topography, access to reliable water, and the exploitation of a mixed-resource economy. This community is most identifiable during the Formative period and reflects a continuing adaptive strategy during periods of affluence and environmental stability. At present, the Archaic and Formative period occupations at LA 5148 appear primarily seasonal in form yet influenced by fluctuating environmental conditions and shifting demographics. Mobility is recognized as highly flexible with occupational duration determinate on a number of variables within the hunter-gatherer continuum.

Doleman (2005:131) discusses this concept with regard to the late Archaic period in south-central New Mexico, however, this construct of flexibility can easily be extended to the Formative period. Doleman (2005:131) argues that spatial structure (i.e., distance between viable biotic zones, climate, water availability, and resource productivity), is broadly reflected in a decrease in the number of resource options in a region, and may have played a significant role in the continuance of hunter-gatherer adaptation. Of equal interest is the subsequent premise that this land use strategy resulted in an increase in scale and frequency in residential movements, possibly impeding the development of agriculture, but establishing a clearly discernible archaeological footprint across the region (Doleman 2005:132). As an alternative, one can view the lands east of the Pecos River as spatially challenged, but congruent and productive, as the Laguna Plata subsistence indicates. Seasonal or cyclical movement to these choice areas may have played a significant role in regional settlement patterns.

For the middle and late Archaic and Formative period, hunter-gatherer populations reduced systemic risk by undertaking and maintaining loose trade networks, managing group size, and practicing what Doleman (2005:119, cf. Yellen 1977) terms behavioral plasticity. As long as the population of a given hunter-gatherer group, or even a regional population, remained below the carrying capacity threshold (i.e., the ability of the environment to support a population), a given adaptive strategy would remain unchanged despite the introduction of innovative technology. In southeastern New Mexico, specifically east of the Pecos River, this is reflected in reoccupation and extended stays at specific locales that provided access to multiple resources (e.g., the Burro Tanks, Boot Hill, Indian Hill, and Laguna Plata sites), and the establishment of intra and inter-regional contacts (Figure 18.9). The result of behavioral plasticity coupled with high mobility is the rejection of socio-complexity and a hierarchal establishment for the region, which may be developing in the Hondo River valley and the Sierra Blanca highlands, and which was present in the Rio Grande valley by the late Formative period. With an adaptive strategy that was flexible and reliant on a mixed resource economy, need for agriculture (i.e., farming) and consequently sedentism, was ignored, or at best superficially accepted. Trade networks may have provided access to domesticated plants, such as maize. As a result, resource acquisition remained flexible and diverse, possibly relying on social networks as a mechanism for access to domesticated plants, rather than become specialists themselves.

While there may be diachronic differences in procurement at this site, we are unable at this time to offer evidence of a change from a foraging/hunting to a sedentary collecting, agricultural based strategy at this time. If our interpretation is correct, we may never identify the agricultural reliance demonstrated in other parts of the Southwest, east of the Pecos River including LA 5148. Although this survey and testing project resulted in a reasonable attempt to understand the broader settlement system associated with LA 5148, additional research will be required before a more accurate interpretation of site use can be established.

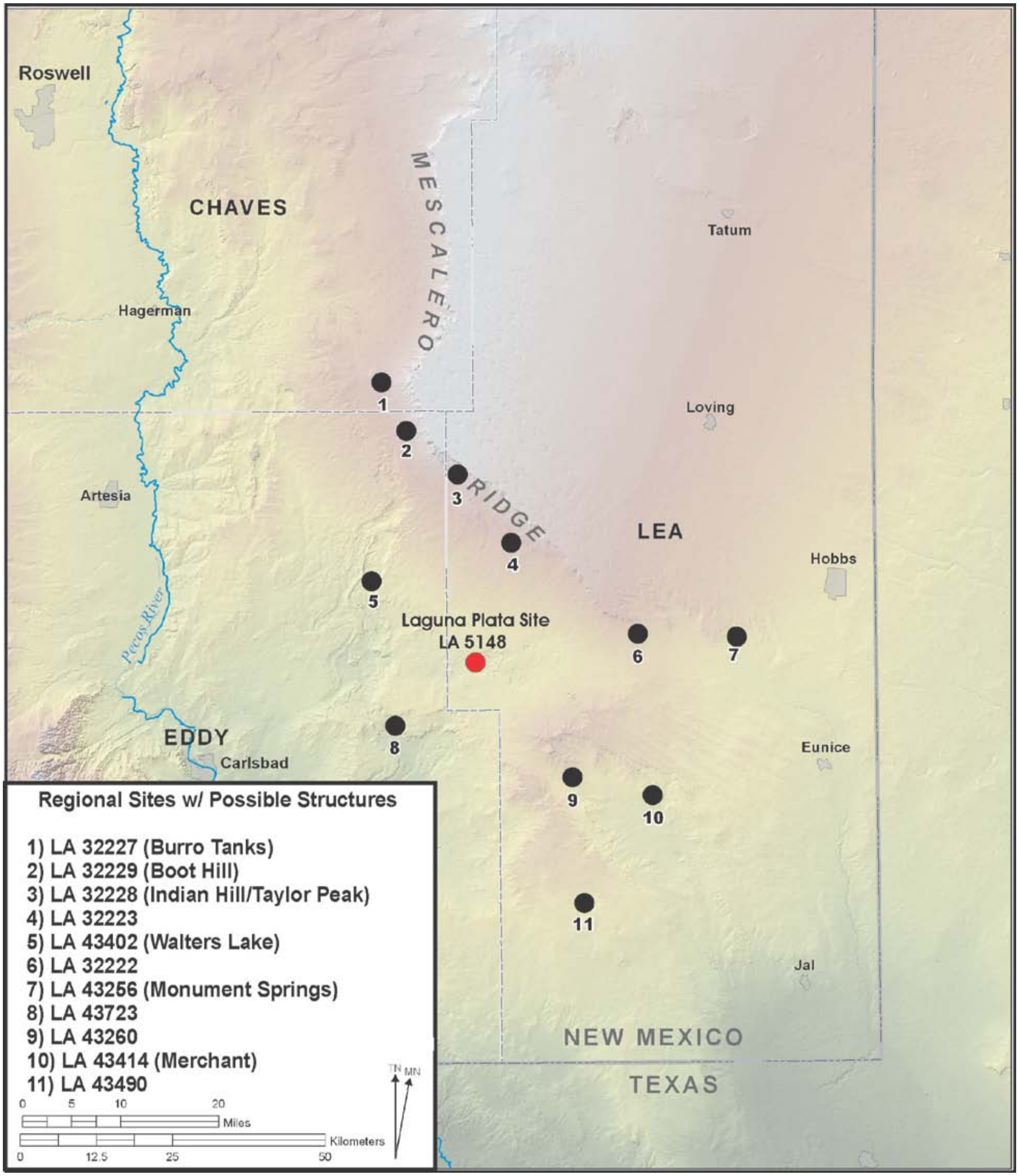

Figure 18.11 Map showing a selection of regional archaeological sites with possible structures in relationship to LA 5148 (based on Leslie 1970)

18.11 Patterns in Regional Interaction

Within the eastern extension of the Jornada Mogollon region, extensive trade networks have yet to be clearly defined and are only indirectly evidenced through intrusive pottery types, nonlocal tool stone, and exotic marine shell (Condon et al. 2008b; Wiseman 2003; Zamora 2000). Prior to the Formative period, the identification of nonlocal tool stone, such as the presence of Alibates silicified dolomite, chert from the Edwards Plateau formation, and Quitaque, or Tecovas jasper, were the most readily recognized, although uncommon, nonlocal materials encountered in southeastern New Mexico (Holliday 1997b). The near absence of nonlocal materials between 5200 B.C. and A.D. 500 may be attributed to low populations, frequent settlement movements, sporadic unplanned episodes of local exchange, and marginal group interaction. Evidence to the contrary may be found not in pottery or tool stone, but in food resources, such as maize. Research at Fresnal Shelter (LA 10101) and High Rolls Cave (LA 114103) in Otero County, New Mexico may point toward the presence of maize from Mexico by at least 1250/1200 B.C. (Lentz 2006:223). After A.D. 750 and the firm entrenchment of ceramic technology, regional interaction is inferred by the presence of nonlocal pottery most notably Mimbres white ware and El Paso brownware variants from west of the Rio Grande, Red Mesa Black-on-white from northwestern New Mexico, and later polychrome pottery from as far south as Chihuahua, Mexico (Hogan 2006:6-45). Despite evidence of regional interaction, quantifying trade and exchange is much more difficult for the region. Following Renfew (1969), trade and exchange are used in the broadest sense as the reciprocal traffic, exchange, or movement of material goods through peaceful human agency (cf. Stewart 1989). Internal and external factors, including social and political dynamics play a critical part in the organization of trade and exchange. As such, two models of trade and exchange are presented here: broad-based networks and focused networks.

Broad-based networks are characterized by hand-to-hand down-the-line exchange and nebulous exchange relationships for the region. Trade items are broadly distributed and generally exhibit gradually declining frequencies with increasing distance from artifact/material sources. Broad-based networks are extensive and may not be controlled by or restricted to formalized relationships between groups. Determining what items and how much of an item is exchanged is determined by the particular needs of a group and not directed by the nature of the exchange system itself (Stewart 1994). Exchanged items are not necessarily held in great esteem, are used in the same manner as locally derived counterparts, and discarded in both ritual (sacred) and domestic context (Stewart 1989:65). Locally, this construct is demonstrated in the recovery of exotic items in burial and caching context, as well as from trash pits. On a fundamental level, artifacts are circulated through a series of exchanges that are nonlinear in form, operate on a personalized level of relationship, and do not operate as a support to a social hierarchy. While ritual or ceremony may operate at some level during the exchange, it does not relate to the general use of the artifacts. This decision-making correlates to a model of sequential hierarchies that function in a flexible manner and which take advantage of aggregated communities (Johnson 1982; Miller et al. 2009). These communities form, aggregate, and disperse as part of the larger cultural system that can include being part of a more established Puebloan system.

Focused networks, as argued by Stewart (1998), contain few contacts and commonly include a large number of artifacts. Often associated with complex societies and ritual, and in the Southwest exemplified by complex polities such as Casas Grandes and Chaco Canyon. Given the hierarchal socio-political substructure of these complex states, it is likely that high-ranking individuals or groups subsidized long-range trading expeditions and linking into established trade systems (LeBlanc 1989:195). Focused exchange may have occurred immediately after the planting season (spring) when groups may have been more sedentary and located in easily identifiable settlements (Stewart 1989). A case for interregional contact can be made for the Formative period and particularly for the late Formative period in the Rio Grande valley, where the sedentary nature of the Puebloan system and an agricultural based subsistence, coupled by marked territoriality, embraced the benefit of trade and exchange. Despite evidence to the contrary, the Formative period remains enigmatic in southeastern New Mexico (Condon et al. 2010a).

Within the greater Jornada Mogollon culture sphere, which takes into account the community structure and interaction among regional populations, including kinship relations, the influence of the Puebloan system identified in the Rio Grande valley, at least in part, is linked to more established polities such as Casas Grandes to the southwest, and judging from the high frequency of El Paso-base ceramics, to the Laguna Plate region as well. However, sedentism may not be measured in the same manner in the Pecos River valley, where an absence of Puebloan architecture is the norm, and high mobility may preclude the establishment of centralized trade centers. Despite more intense occupation between A.D. 1100 and 1300 in the Jornada Mogollon region, the low efficiency and high transport cost of direct trade may have weakened the social relationships between the Pecos River valley and trade centers to the west (Whalen and Minnis 2001:195). Considering this interpretation, the advantage of broad-based nonlinear trade and exchange during the late Formative period at the Laguna Plata site, may be more realistic than focused relationships and would explain the low frequency, but relatively high diversity of nonlocal artifacts.

Within the current testing project carried out at LA 5148, 20 pottery types were identified. Of the 20, 14 are considered by Hogan (2006:6-43) to be indigenous to the Jornada Mogollon region and five types are considered intrusive (Figure 18.10). The remaining pottery classification is for indeterminate types. While many of these regional types may be considered indigenous, they are probably not local to the LA 5148 area. In fact, it may be argued that *indigenous* being a relative term may preclude all other pottery types except types manufactured in the Sierra Blanca region, Mescalero Plain, and Pecos floodplain. It is suggested here that pottery types, such as El Paso Brown, El Paso Bichrome, and El Paso Polychrome, be considered with clearly exotic types, including, Mimbres white ware, Ramos Polychrome, Gila Polychrome, and St. John’s Polychrome. The exception to the rule being those locally manufactured pottery types that mimic the exotic (Hogan 2006:6-46).

The diversity of intrusive pottery types suggests interaction with areas adjacent to the Pecos River and those along the far western extension of the Jornada Mogollon and beyond (e.g., St. Johns Polychrome). More regionalized pottery types include Jornada Brown, South Pecos Brown, Middle Pecos Brown, and McKenzie Brown and are affiliated with the Sierra Blanca region and middle Pecos Valley (Hogan 2006; Wiseman 2003). Lincoln Black-on-red, Three Rivers Red-on-terracotta, Alma Plain, Corona Corrugated, and Chupadero Black-on-white also originate in the northern Jornada Mogollon region characterized by the Sierra Blanca Mountains (Hill, cf. Peterson 2001; Runyan and Hedrick 1987; Wiseman 2003). El Paso brown ware variants, including El Paso Brown, El Paso Bichrome, and El Paso Polychrome are associated with the Rio Grande valley of west Texas and the Tularosa Basin of New Mexico (Miller 1995; Miller and Kenmotsu 2004). Mimbres white ware is tentatively sourced to the Mimbres valley west of the Rio Grande River, while St. John’s Polychrome is associated with Northwestern New Mexico. Gila Polychrome is associated with southwestern New Mexico. Ramos Polychrome and Playas Red pottery types are traditionally associated with northern Chihuahua, Mexico.

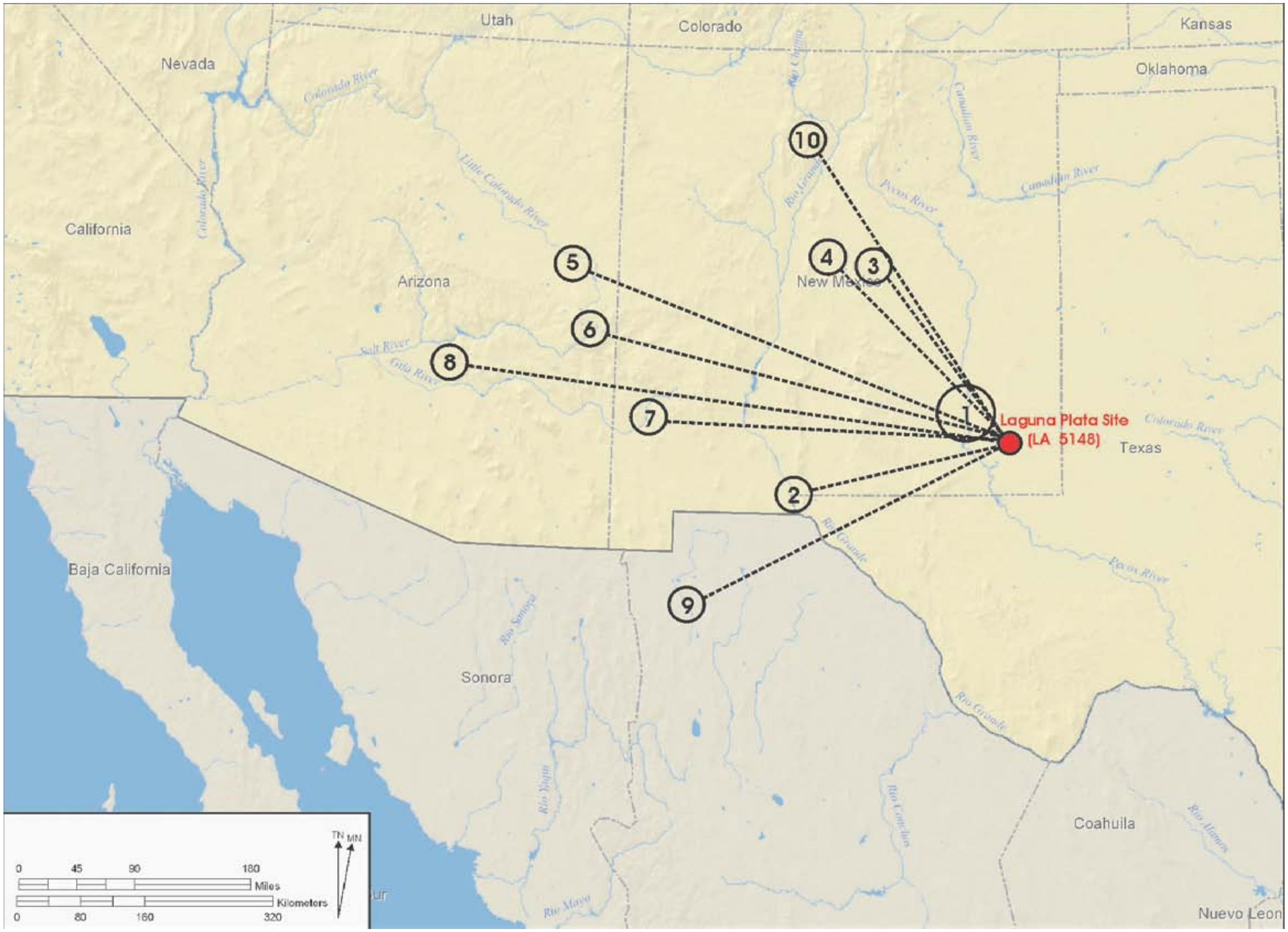

Figure 18.12 Source areas for intrusive artifacts recovered at LA 5148

1) Jornada Brown, Jornada Decorated, South Pecos Brown, Middle Pecos Brown, McKenzie Brown, and Corona Corrugated; 2) El Paso brownware, El Paso Brown, El Paso Bichrome, El Paso Polychrome, and El Paso Decorated; 3) Three Rivers Red-on-terracotta and Lincoln Black-on-red; 4) Chupadero Black-on-white; 5) St. Johns Polychrome; 6) Alma Plain; 7) Mimbres Black-on-white; 8) Gila Polychrome; 9) Ramos Polychrome and Playas Red; and 10) Valles Calderas obsidian source.

Included in the discussion on trade and exchange is the identification of obsidian at LA 5148 from the Jemez Mountain range of north-central New Mexico. The presence of a nonlocal lithic material indicates possible long-range transport from the Valles Caldera outcrops of Cerro Toledo Rhyolite and Valles Rhyolite (Shackley 2005). The general morphology and size of the cobbles, as well as the flaking and cutting properties of obsidian, made this desired tool stone a transportable commodity. As sources outside the Valles Calderas are almost nonexistent (e.g., secondary transport in the Rio Grande) in New Mexico, the occurrence of obsidian can be, in all likelihood, attributed to trade and/or exchange. Temporally, we see a florescence of obsidian after A.D. 200 in the Rio Grande region marking the commonality of ceramic technology and the start of the Formative period (Miller and Kenmotsu 2004). For the Pecos River valley, this temporal distinction is more ambiguous, but one that may warrant further attention.

Nonlocal artifacts, recovered during the test excavation, site survey, and in the LCAS collection, are characterized by a low frequency count for any single artifact type, with the exception of El Paso brownware and Chupadero Black-on-white. The prevalence of Jornada Brown and Corona Corrugated suggest these pottery types are more local than not to the Laguna Plata site area, but are still likely being manufactured west of the site. The high frequency of pottery attributed to the El Paso region of Texas may suggest a more established social relationship with this region. Chihuahuan ware, including Ramos Polychrome and Playas Red, further strengthens a network connecting Casas Grandes with southeastern New Mexico. This is in keeping with trade system models proposed by LeBlanc (1999) and Whalen and Minnis (2001) and suggests Casas Grandes served as a possible clearinghouse for pottery and other items moving northeast. As we examine the distribution of Laguna Plata pottery, a pattern of east moving trade items is demonstrated. In fact, the artifact assemblage indicates an almost total absence of materials moving west from the Southern High Plains or from central Texas. While the absence may be misleading in that perishable items may have been traded, such as bison meat or hides (see faunal analysis), the pattern is intriguing and begs the question as the relationship between populations inhabiting LA 5148 and those to the east.

18.11.1 Summary

Evidence of contact at LA 5148 can be found in the identification of intrusive pottery and tool stone across the site and in the LCAS collection. Whether this interaction is buffered through a broad network of trade and exchange or is the result of direct interchange along trade routes is unclear. The presence of pottery types sourced to the west of the project area further suggests interaction with populations within and peripheral to the Jornada Mogollon region. As noted by Kenmotsu et al. (2008), the role that regional interaction plays in the adaptive strategies carried out in the Jornada Mogollon region suggest a higher level of importance than previously allotted. It is suggested that for the Formative period in southeastern New Mexico, the development of interregional trade and exchange systems is illuminated by the introduction of pottery, population increase, and seasonal aggregation of populations into general core areas, such as LA 5148. Although undefined, the acquisition of intrusive items may express the development of sociopolitical complexity and possibly hierarchical social stations within the region. The construct of sociopolitical complexity, although not readily applied to the eastern extension of the Jornada region, is one of significance for the project area. Questions relating to the interaction and exchange of trade goods and ideas between the Rio Grande valley and the Pecos River valley merit attention and future inquiry.

19.0 Current Research Assessment: Settlement, Subsistence, Technology, and Regional Interaction

Peter C. Condon

This section addresses the research questions in Chapter 5. The questions pertain to four research topics: 1) settlement, 2) subsistence, 3) technology, and 4) regional interaction. Subsequent to the summary paragraphs is a research question based on data derived during this testing project. While each of the research domains is tentatively viewed as a separate entity, each is interrelated and some have overlapping explanations.

19.1 Settlement

Hypothesis 1: *Early Archaic settlement patterns at the Laguna Plata site will reflect warm-weather occupations during which a mixed resource base would have been exploited. These components will be small in size, with a technological organization that focused on a biface-oriented reduction strategy. Ground stone technology will be minimally reflected within the Early Archaic component.*

In their overview of the Archaic period, Sebastian and Larralde (1989:53) argue the primary factors limiting a further understanding of Archaic adaptations for the Jornada Mogollon region can be posed as problems of identification and preservation. This interpretation is reiterated by Beckett and MacNeish (1994:336) with the development of their Chihuahua Tradition. Today, these factors are considerations at the Laguna Plata site. Using data sets derived by Runyon (1971), Haskell (1977), and Laumbach et al (1979), as well as the current testing project, an Archaic presence is discernible at the site. This presence, however, is ambiguous aside from diagnostic projectile points, due in part to preservation and the palimpsests of later occupations. Moreover, the processes that lend themselves to preservation are often lacking in areas were the archaeology is most visible. Comparable data sets from Fresnal Shelter, Fallen Pine Shelter, and High Rolls Cave (Akins 2006) provide detailed analysis for the middle and late Archaic periods in the Jornada region.

As presented by Akins (2006), seasonal shift in the distribution of game and herd animals to one focused on the abundance and availability of plant species is in keeping with climatic changes expressed by increasing aridity for the middle and late Archaic period. Increased aridity, however needs to be quantified, as intervals of above average precipitation and favorable climatic conditions often characterized these periods (Doleman 2005; Hard and Roney 2005). Interpreting how middle and late Holocene populations at Laguna Plata adjusted to shifts in climate is problematic. Moving beyond the diagnostic artifacts, which are limited to projectile points and fragments, is Feature 2, a shallow pit house. Remnant wood charcoal collected from Feature 2 provided a late Archaic age range of A.D. 230 to 390 (UGA 6724). Based on the construction and depth of Feature 2, it appears that the structure reflects a spring or late fall, rather than a summer shelter. This seasonal estimate may parallel hunting of artiodactyls at the site and imply an extended, but still short-term residency. It is further speculation that Archaic occupations at the Laguna Plata site included both cold and warm weather site use. This pattern is probably repeated during the Formative period with greater use after the rainy season or in the early spring.

Hypothesis 2: *Early and middle Formative period use of the Laguna Plata site will exhibit evidence for a warm-weather, residential pattern of mobility. These occupations may exhibit the use of ephemeral shelters, increased assemblage density and diversity, and increased frequency in ground stone artifacts.*

Hard (1983) argued for more intense use of low-lying environments during the Formative period, specifically after A.D. 600 for the Jornada Mogollon region. Climatic conditions prior to A.D. 940 suggest average and above average annual precipitation and corresponding environmental stability would have provided optimum resource availability on a seasonal basis. With environmental stability is the expected flourishing of plant and animal communities, or at the very least, the development of ecozones supporting the proliferation of species. The Laguna Plata basin may have served as one such niche, where springs and seeps supported a diversity of plant and animal communities.

The diagnostic artifact assemblage dating to the Formative period suggests multiple occupations at the Laguna Plata site, probably during the spring and after the summer rains. A large number of projectile points indicate hunting was probably a major activity, as indicated by the faunal assemblage. Feature 3, a shallow pit house, yielded two age ranges, A.D. 1040 to 1260 (UGA 7215) and A.D. 1040 to 1220 (UGA 7215), both overlapping during the middle to late Formative period. Based on the construction and depth of Feature 3, it appears that this structure reflects a spring or late fall, rather than a summer shelter. This seasonality may parallel hunting of artiodactyls and imply an extended, but short-term residency.

The Laguna Plata site may have served as a residential site or base camp during the Archaic and Formative periods. The site re-occupation and density of the artifact assemblage attests to the importance of this site locus to regional hunter-gatherer groups. The construction of ephemeral pit houses suggests temporary extended site use, perhaps during cooler months of the year, such as spring or fall. Occupation appears to have targeted areas that provided suitable topography, access to reliable water, and exploitation of a mixed resource economy. This community is most identifiable during the Formative period and reflects a continuing adaptive strategy during periods of affluence and environmental stability. At present, the Archaic and Formative period occupations at the Laguna Plata site appear primarily seasonal yet were influenced by fluctuating environmental conditions and shifting demographics. Mobility is recognized as highly flexible with occupational duration based upon a number of variables within the hunter-gatherer continuum. This interpretation points toward understanding hunter-gatherers through a more inclusive set of attributes, such as organizational properties, cultural ethos, religion, in addition to subsistence, settlement, and technology. These constructs, while difficult to define within the archaeological record, are critical to advancing our understanding of the dynamics of hunter-gatherer cultural systems in the region and provide future goals towards a broader understanding of prehistoric adaptive strategies.

19.2 Technology

19.2.1 Archaic Period

Hypothesis 1: *During periods of resource congruence and abundance, Archaic hunter-gatherers occupying the Laguna Plata basin will exhibit a tool kit composed of multifunctional flaked stone tools indicative of a bifacial reduction strategy used to exploit a mixed resource base and take advantage of opportunistic hunting of artiodactyls when encountered.*

19.2.2 Formative Period

Hypothesis 1: *During periods of resource congruence and abundance, Formative-age groups will exhibit a tool kit composed of multifunctional flaked stone tools indicative of a core/flake reduction strategy used to exploit a mixed resource base.*

Hypothesis 2: *In the face of lithic abundance, as noted within and around the basin environment, we would expect to encounter a multidirectional approach emphasizing a random series of reduction strategies with regard to tool manufacture. The technological strategies associated with this reduction strategy represent one element in an array of cultural adjustments that are focused on available resources and reflect a form of formal expediency.*

Hypothesis 3: *Lithic resources consist primarily of small-sized resources, consequently, hunter-gatherer groups will utilize informal slab metates and cobble manos to process both faunal and floral resources* *common to the basin. The availability of sandstone outcrops at the Laguna Plata site will provide the primary material for ground stone manufacture.*

Hypothesis 4: *Ceramics identified within early Formative components will be comprised exclusively of jar vessel forms that serve both a cooking and transportable storage function.*

Hypothesis 5: *Feature morphology and construction will reflect informal pit structures and limited-use domestic hearths rather than formal rock-lined pits or annular rock-ring roasting pits.*

Technological issues are addressed through the range of artifacts identified at the Laguna Plata site and indirectly linked to site activities and site use. Within current operating models of hunter-gatherer settlement and subsistence, technology is viewed as an immediate response to mobility and resource availability. With this in mind, the organization of technology emphasizes a generalized hunting and gathering adaptation that, based on the projectile point assemblage, underlies a hunting exploitation strategy (Vierra 1994:21). Arguably, this organizational strategy can be extended from the middle Archaic through much of the Formative period for southeastern New Mexico. As such, the hypotheses presented in Chapter 5 can be combined into the comprehensive question, *does technology shift through time, and if so, how is this shift demonstrated at the Laguna Plata site?*

The Laguna Plata site contained a variety of artifact assemblages including thousands of pieces of lithic debitage, but a low frequency of cores and flaked stone tools. In a similar fashion, ground stone was noted in higher concentrations in the southern portion of the site where sandstone outcrops were accessible. Ceramics were recovered throughout the site, but in particular along the ridge top north and south of the access road. Features were consistent in form and function and identified primarily south of the access road. The range of data documented at the Laguna Plata site was centered on quantity and diversity and focused on preparing an interpretative platform from which further statements on past activities could be developed.

Raw material selection points toward a ubiquitous preference for chert and quartzite across the entire assemblage and is the result of availability and occurrence of the Ogallala formation associated with the caprock margin of the Southern High Plains (Haskell 1977; Holliday 1997b). While other materials are used, their occurrence might be limited to several factors, including access, quality, and functional response to environmental needs. The preference for coarse-grained material types such as basalt and quartzite may preclude the need for fine-grained tool stone that produces a finer cutting edge. Moreover, the low occurrence of rhyolite may support the premise of a collection strategy that primarily relies on raw materials that are nearby or which can be acquired opportunistically during the course of other activities. The obsidian sourcing data presents one tentative exception to this interpretation. It is unclear whether obsidian found its way to the Laguna Plata site through trade and exchange or as the result of a chance find. Concurrent with this is the interpretation that no obvious trading networks or extensive contact with populations outside of the region existed with regard to tool stone. This is in keeping with current models of prehistoric land use for the region, one that suggests that stone is procured from local gravel sources and accessible outcrops as secondary events.

The debitage assemblage analysis indicates a variety of reduction techniques are present, and equally critical, that stone conservation and tool maintenance may not play pivotal roles in the structure of technological organization at the site. As noted by Miller (2007), Condon et al. (2009, 2010a, 2010b), and more recently by Railey (2010), reduction techniques utilized during the Late Archaic and Formative periods appear to fall between a formal-biface oriented reduction strategy and one that is best described as an informal core/flake trajectory. Moreover, material conservation does not seem to play a major role in tool maintenance at many sites within the Laguna Plata region, suggesting that access to tool stone was not necessarily problematic.

The core assemblage is reflective of the debitage assemblage in that both fit the profile of expected early through late reduction of core/flake technologies. The frequent occurrence of multidirectional cores suggests a reduction strategy that is flake oriented, random, opportunistic, and in all likelihood, expedient rather than formalized. Using the mean core size and mean flake length, there is a pattern that almost precludes biface-oriented reduction, suggesting that flaked stone tools, specifically projectile points, may have been made from a core/flake technology rather than a bifacial core trajectory. This is in keeping with a Formative period organizational strategy that emphasizes the bow and arrow rather than larger atlatl or spear-type technology.

This interpretation is supported by the projectile point analysis, which suggests a subtle, yet distinguishable, pattern that segregates dart from arrows points. However, the more critical question focuses on the perceived shift in technology for the region. For the southeastern New Mexico region, this implication suggests the possible knowledge and utilization of multiple technologies through time, albeit on an intermittent and sporadic basis. The more acceptable age range for the shift from atlatl dart to the manufacture of arrow points in the southeastern New Mexico region is between A.D. 500 and 700 (Railey 2010:266). While Fresno, Scallorn, and Harrell types traditionally reflect arrow points, the general wide age range associated with point types prior to the late Formative period do not provide much assistance in narrowing this transition in technology.

The flaked stone tool assemblage, including informal and bifacial tools, included a relatively small sample group. Several trends, marked by an emphasis on limited use tools made primarily from chert or fine-grained quartzite, were identified. The technology of the informal assemblage shows little variation despite a probable extended occupation at the Laguna Plata site, and in particular the C-10-C locale. The TRC survey of the remainder of the site tends to support the near absence of retouched flaked stone tools, which may be the result of local collecting over the years, resulting in a bias in the recovered assemblage. However, the easy access to lag deposits from which adequate stone tools could be manufactured, in all likelihood, accounts for the general low frequency of retouched artifacts at this site.

In reviewing the biface assemblage, two observations stand out. Over 75 percent of the artifacts classified as bifaces were broken or incomplete. These artifacts may have been in a pre-projectile or manufacturing trajectory, but their incomplete form precludes a more definitive functional interpretation. The second observation is the mean length of the unbroken biface assemblage is less than 3 cm, suggesting a relatively small specimen. These bifaces, in all likelihood, reflect tools that have been roughly shaped, but show irregular lateral margins, and deep flake scars. While these artifacts have been thinned, they are unfinished with regard to tool thickness. The identification of specific tool forms, including a drill, an awl, and a scraper, may reveal specific activities at the Laguna Plata site. As presented in Haskell (1977), the presence of these artifact types suggest the scraping of flesh or hides, the drilling of larger items, such as bone or wood, and the more refined inscribing or perforating conducted by awl or graver.

Grinding implements, which were manufactured almost exclusively from coarse material, was easily obtained at the site. Metate types include slab, flat/concave, and basin forms. Manos range from circular/ovate to irregular in morphology with intentionally shaped rounded forms and unshaped cobble forms also present. Most of the manos were considered the one-hand type. Conspicuously absent were formal ground stones, such as trough metates, which are documented in increasing frequencies as agriculture begins to become a primary activity. These types of formal grinding tools are typically associated with extended occupations, and maize processing, and were not expected at the Laguna Plata site. The general informal, slab metates identified during testing correspond with seed processing and highly mobile populations (Adams 1999; Hard 1983).

The ceramic analysis provided data on chronology, form, and function. Occurring with the most frequency in the ceramic assemblage is Jornada Brown, which in much the same manner as other plain brownwares, provides a relative temporal range for a given region. In this case, Jornada Brown dates between A.D. 200/400 to 1250/1350 and includes the entirety of the Formative period in the Laguna Plata region. South Pecos Brown occurs with less frequency, but spans a period of about 300 years (A.D. 900–1200). These brownwares appear to correlate stylistically with similar undecorated brownware types, including El Paso Brown. Nonlocal brownware variants that, in all likelihood, source northwest and southwest of the Pecos River Valley, include Middle Pecos Micaceous Brown, McKenzie Brown, and Alma Plain. Middle Pecos Brown dates between A.D. 500 and 1075 and overlaps with Alma Plain, which dates between A.D. 200/400 and 650. McKenzie Brown occurs as early as A.D. 1100 and phases out by around 1300. Each of these types is present in low frequencies within the LCAS assemblage.

Within Lehmer's (1948) Jornada Mogollon culture sphere are the Rio Grande pottery types: El Paso Brown, El Paso Bichrome, and El Paso Polychrome. These pottery types also occur in relative low frequencies, but reflect the transition from a plain brown, which flourished from A.D. 200 to 1000/1100, to painted wares after A.D. 800/1000 in the Rio Grande valley. The subsequent introduction of El Paso Bichrome (A.D. 800/1000–1100/1250) and the gradual shift to polychromes (A.D. 1000/1100–1450) is identified in the assemblage. El Paso Polychrome, one of the more predominate nonlocal pottery types, effectively points toward a regional influence at LA 5148 post A.D. 1000. The Rio Grande valley, including the adjacent Hueco Bolson and Tularosa Basin, falls with the traditional boundary of the Jornada Mogollon region, and holds a tentative association with the Pecos River valley to the east, despite the general absence of locally made decorative pottery in the Pecos River valley. Moreover, the identification of clays and temper material, as suggested by Wiseman (2003) and Hill (cf. Zamora 2000), suggest most of the brownware pottery was produced outside the Laguna Plata area, primarily in the Sierra Blanca region or the Rio Grande area associated with El Paso, Texas.

As discussed by Zamora (2000:70), the similarities and presence of pottery types within and between these two areas suggests populations did not exist in isolation. This is saliently demonstrated when more exotic pottery types are discussed. The presence of pottery types northwest, far west, and far southwest of the Laguna Plata site can best be explained through regional down-the line interaction rather than direct trade. The low occurrence of any one, nonlocal pottery type, with the exception of Chupadero Black-on-white and Corona Corrugated, generally supports this interpretation. Not discounting direct use of the Pecos River as an access route, the general high diversity, low frequency of the exotics, and distance suggests that trade and exchange was indirect. Mimbres white wares date between A.D. 750 to 1130/1150 east of the Mimbres Mountain range and overlaps chronologically with Jornada Brown, Middle Pecos Brown, South Pecos Brown, El Paso Brown, and Alma Plain; all pre-date what is considered the primary occupation at the Laguna Plata site. Chupadero Black-on-white and Three Rivers Red-on-terracotta originate northwest of the Laguna Plata site and date post A.D. 1100, with the highest frequencies dating between A.D. 1100 and 1300. Playas Red is thought to be a product of the Casas Grande region of Mexico and also dates post-A.D. 1100 and represent a second period of greater site usage.

Ceramics dating after A.D. 1200 tend to support the traditional interpretation of site occupation at the Laguna Plata site (Haskell 1977; Runyan 1971, 1972). St. John's Polychrome and Corona Corrugated reflect occupational events as early as A.D. 1200 and 1225, respectively. Lincoln Black-on-red, Ramos Polychrome, and Gila Polychrome indicate site use after A.D. 1300 and terminating by A.D. 1400/1450. This is slightly later that suggested by Runyan (1971) and Haskell (1977), who argued for an A.D. 1300/1350 site abandonment. The record of site activity at Laguna Plata clearly demonstrates a consistent, although not continuous, use of the western margin of the Laguna Plata playa throughout the Formative period. The diversity in the ceramic assemblage establishes a pattern of diachronic site activity that involves interaction at least on a secondary level of influence for the region. The data derived from the LCAS ceramic assemblage clearly indicates three primary points: 1) that the Formative period occupation at the Laguna Plata site, particularly the C-10-C locale, was comprehensive, spanning in part the entire Formative period until A.D. 1300/1350; 2) multifunctional narrow-mouthed vessel forms occur in greater frequency suggesting mobility rather than sedentism; and 3) the diversity of non-local pottery types points toward greater regional interaction and social organization.

Forty-four features were documented during testing. Most of the features were classified as small thermal pits (i.e., hearths) that were less than 2 m in diameter. The number of discernible features is indicative of moderate-to-high levels of site activity, repeatedly over time that involved both the processing of resources, the possible storage of resources (Feature 6), and the sheltering of the site inhabitants. The similarity in feature type suggests commonality in function that is more akin to small hearths rather than large processing features. The paucity of large processing features may relate to a scarcity of resources that would necessitate the processing of resources on a large scale. In contrast, the Laguna Plata site exhibits an elevated frequency in feature numbers, which may not correlate with any single period of site use, but may relate to greater usage of the site over time. The large roasting pits, defined as burned-rock middens, annular rock rings, and crescent middens of burned rock, are absent. This absence may suggest processing of resources, such as agave, may not have been a primary activity. More likely, environmental conditions were not favorable to the flourishing of this resource and, therefore, it is not present in the archaeological record.

19.3 Subsistence

Hypothesis 1: *Archaic use of the Laguna Plata site will reflect a seasonal extractive subsistence strategy that exploited a variety of resources, highlighted by small game and nonseed-bearing plant species.*

Hypothesis 1: *Due in part to increased aridity and population pressure, Formative period use of the Laguna Plata site will reflect broad-spectrum resource acquisition of perishable and nonperishable resources that are reflected in the seasonal exploitation of small game and seed-bearing plant species.*

Hunter-gatherers of the middle through late Archaic and Formative periods adjusted their resource selection and scheduling to a seasonally determinate biotic selection. As such, during the summer rainy seasons, floral resources would be more available and basin exploitation would have experienced its greatest activity. Based on current floral availability, it is expected that mesquite beans and seeds from acacia, yucca, amaranth, chenopod, sunflower, and drop seed would have provided a food source that could have been consumed immediately after processing or stored for future use. Artiodactyls, including bison, would have also provided an infrequent, but valued food source; however, within the basin proper, small game, such as cottontail or jackrabbit would have been the most available. Undoubtedly, changes in basin exploitation over the last 3,000 years can be accounted for by the relationship between climate, resource diversity, and population pressure. Major transitions from a mixed-resource economy that exploited a broad spectrum of seasonally based resources, however, are gradual in nature and ephemerally present in the archaeological record. Several characteristics of Formative period subsistence strategies are more expressive than others. For instance, the increased value of seed-bearing plants is evidenced by increased frequencies of ground stone implements. Storage, both transportable (e.g., jars and baskets) and fixed (e.g., storage pits) infer that nonperishable resources were becoming increasingly important as a means of delayed-economic return in anticipation of cold-weather resource scarcity.

When the primary resources identified at the Laguna Plata site are assessed, *Lepus californicus* (black-tailed jackrabbit) and *Sylvilagus audubonii* (desert cottontail) are the dominant resources, although artiodactyls reflect a significant resource probably acquired on an opportunistic basis. Smaller reptiles, as well as *Terrapene ornate* (Western box turtle), and *Colubridae* (colubrid snakes), may be more opportunistic rather than a primary staple of the inhabitants diet. Plants, such as *Elymus salinus* (wild rye) and *Porceae* (grass seed), although not identified in the analyses, were exploited at Laguna Plata. *Prosopis* sp. (mesquite) was present, but in low quantities and in ambiguous context with regard to consumption. *Zea mays* (maize) was identified in very low quantities. The minimal presence of *Zea mays* (maize) may be accounted for by the small sample size submitted for analysis, but more likely is an absence of horticulture.

The abundance of resources in the Laguna Plata site environs suggests the hunting of small mammals provided a consistent resource, but that opportunistic hunting of medium to large mammals, including bison, commonly occurred. Seasonal availability was probably a major factor in resource selection. Climate and precipitation would have played a critical component in available resources. It is possible, but unlikely, that the occupying groups revisited the same locale within a yearly residential round. The feature types identified as late Archaic and Formative period in age indicate an extended, but still short term, occupation. The site occupants practiced a broad-spectrum subsistence strategy that in all likelihood targeted seasonally available resources that provided a relatively high return rate. Higher ranked species were acquired opportunistically, as indicated by the faunal assemblage. Maize (*Zea mays*) may have been transported along residential rounds as a supplemental food source. Based on the subsistence data identified, it is suggested that basin utilization occurred during the cooler weather months and targeted seasonally available resources.

19.4 Intraregional and Interregional Interaction

Hypothesis 1: *During periods of prolonged residential occupation and seasonal resource incongruence, foraging groups will exhibit elevated inter-regional interaction, resulting in a moderate to high presence of nonlocal artifact types.*

Exchange and interaction on a regional scale was primarily evaluated through nonlocal pottery types tentatively seen as a marker of regional interaction. Whether this interaction is buffered through a broad network of trade and exchange or is the result of direct interchange along trade routes is unclear. However, an argument can be made for asymmetrical or facultative mutualism and indirect reciprocation rather than focused inter-regional interaction. As all the pottery identified at the Laguna Plata site can be considered intrusive (Wiseman, 2010, personal communication), it is difficult to address or identify specific events in trade and exchange or how they relate to environmental change. The frequency of pottery associated with the Sierra Blanca highlands points toward a relationship northwest of the Laguna Plata site. Direct or indirect interaction with the Henderson and Bloom Mound sites, or even the pit house settlement of The Fox Place site (LA 68188), all of which demonstrate temporally contemporaneous components (i.e., between A.D. 1250–1400) (Speth and LeDuc 2007:45) is suggested.

The presence of pottery types sourced to the west of the project area further suggests some cultural linkage with populations within and peripheral to the greater Jornada Mogollon region. Alternatively, no evidence for interaction with populations with the plains was identified. As noted by Kenmotsu et al. (2008), the role that regional interaction plays in the adaptive strategies carried out in the Jornada Mogollon region suggest a higher level of importance than previously allotted. It is further suggested that for the Formative period in southeastern New Mexico, the development of cultural interaction is promoted by the seasonal aggregation of populations into a recognized locale, one in which trade and exchange is facilitated. The Laguna Plata site, with its sweeping vista, freshwater springs, and diverse resources, may have served as one such locality. Access to hunter-gatherer groups, allowing the fortuitous and deliberate alike the opportunity for interaction on a limited basis, was in all likelihood afforded during their occupation at the Laguna Plata site.

20.0 Recommendations and Management Concerns

Peter C. Condon

TRC Environmental, Inc., Albuquerque, New Mexico under contract with the BLM, Carlsbad Field Office, conducted the required archaeological and geomorphologic investigations at the Laguna Plata site (LA 5148), Lea County, New Mexico, as well as analyses of artifact collections acquired by the Lea County Archaeological Society. Under the BLM's Permian Basin Mitigation Program, Task Order 05 was done to provide a more comprehensive interpretative assessment of the Laguna Plata site.

The archaeological investigations conducted to fulfill these obligations yielded significant information towards addressing regional research issues as they pertain to the Laguna Plata site. The results of the present testing project offer insights into managing the cultural resources and future activities at the site. This testing project documented cultural context, inventoried and excavated features, mapped and collected artifact assemblages, and recovered chronometric data from structures at the C-10-C locale. This has illuminated several directions to pursue regarding future research.

First is geoarchaeological investigation. Delineating soils helped establish many of the occupational surfaces at the site are differentially deflated through aeolian activity and alluvial incising, resulting in the intermixing of cultural components. Therefore, one consideration recommended for future research is to evaluate the extent of the buried cultural deposits outside of the main artifact concentrations. The geoarchaeological investigations demonstrated a dichotomy between contextually absent, yet highly visible, surface concentrations and intact buried cultural deposits. Since the surface assemblages have been documented, future research should target the dunal areas bordering the eastern portion of the site and have preserved intact cultural deposits. The second recommendation focuses on areas of accumulated sands along the southeastern margin of the Laguna Plata basin. The depth of these deposits illustrates the potential for late Pleistocene and early Holocene deposits. Investigation of these deposits will need to be accomplished with use of mechanical equipment because of the depth of the soil horizons. It is recommended that the newest methods be employed to broaden our knowledge of the past and assess their effectiveness (Quigg et al. 2002:389).

The artifact assemblages provided insight into hunter-gatherer activities and technologies and augmented the chronometric data. Future research should continue to identify and refine the periods of greater site occupation through more exacting radiocarbon testing. In addition to submitting charred seeds and wood charcoal for radiocarbon dating, other methods such as archaeomagnetic, thermoluminescence, optically stimulated luminescence, and infrared stimulated luminescence dating may prove useful.

The ceramic assemblage has potential to yield additional information. Further compositional analysis of ceramics using Neutron Activation Analysis (NAA) will not only enhance the database for the region, but will also provide insight into the economic organization and mobility strategies at the Laguna Plata site.

Also of interest is the subsistence data, which has yielded valuable information for future research. The identification of *Elymus salinus* (wild rye) and *Hordeum pusillum* (little barley) suggests a seasonally focused flora procurement strategy. In addition, the recovery of *Zea mays* (maize) adds to a limited database that can be better evaluated on a regional level. Identifying what resources are being exploited through time and how these resources were processed will provide an important factor in considering future research.

Within the realm of site management, the primary objective of this testing project was to reinvestigate existing data sets and assess the contextual integrity of the site. The testing strategy was purposefully limited in extent to help establish a framework for future research and demonstrate the utility of key analytical methods. TRC believes the testing, geophysical survey, and geoarchaeological investigations fulfilled the goals of this project. Future research at the Laguna Plata site in particular, and within the Permian Basin in general, can move beyond documentation and towards developing a detailed and refined regional synthesis of prehistoric and early historic occupations.

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Appendix A: Radiocarbon Assay Data

The University of Georgia
Center for Applied Isotope Studies

RADIOCARBON ANALYSIS REPORT

June 30, 2010

Adriana Y.Romero
TRC Environmental
5400 Suncrest Drive, Suite D-1
El Paso, TX 79912

Dear Mrs. Romero

Enclosed please find the results of ^{14}C Radiocarbon analyses and Stable Isotope Ratio $\delta^{13}C$ and analyses for the samples received by our laboratory on June 9, 2010.

UGAMS #	Site #	Feature	$\delta^{13}C$,‰	pMC	±	^{14}C age, years BP	±
6723	LA5148	6	-24.7	81.19	0.26	1670 25	
6724	LA5148	2	-24.9	80.54	0.25	1740 25	
6725	LA5148	3	-25.7	89.40	0.28	900 25	

The charcoal sample was treated with 5% HCl at the temperature 80°C for 1 hour, then it was washed and with deionized water on the fiberglass filter and rinsed with diluted NaOH to remove possible contamination by humic acids. After that the sample was treated with diluted HCL again, washed with deionized water and dried at 60°C. For accelerator mass spectrometry analysis the cleaned sample was combusted at 900°C in evacuated / sealed ampoules in the presence of CuO. The resulting carbon dioxide was cryogenically purified from the other reaction products and catalytically converted to graphite using the method of Vogel *et al*. (1984) Nuclear Instruments and Methods in Physics Research B5, 289-293. Graphite $^{14}C/^{13}C$ ratios were measured using the CAIS 0.5 MeV accelerator mass spectrometer. The sample ratios were compared to the ratio measured from the Oxalic Acid I (NBS SRM 4990). The sample $^{13}C/^{12}C$ ratios were measured separately using a stable isotope ratio mass spectrometer and expressed as $\delta^{13}C$ with respect to PDB, with an error of less than 0.1‰. The quoted uncalibrated dates have been given in radiocarbon years before 1950 (years BP), using the ^{14}C half-life of 5568 years. The error is quoted as one standard deviation and reflects both statistical and experimental errors. The date has been corrected for isotope fractionation.

Sincerely,

Dr.Alexander Cherkinsky

The University of Georgia
Center for Applied Isotope Studies

RADIOCARBON ANALYSIS REPORT

September 2, 2010

Adriana Y.Romero
TRC Environmental
5400 Suncrest Drive, Suite D-1
El Paso, TX 79912

Dear Mrs. Romero

Enclosed please find the results of ^{14}C Radiocarbon analyses and Stable Isotope Ratio $\delta^{13}C$ and analyses for the samples received by our laboratory on August16, 2010.

UGAMS #	Site #	Sample #	Material	$\delta^{13}C$, ‰	pMC	±	^{14}C age, years BP	±
7210	LA5148	1	sediment	-23.0	55.78	0.2	4690	25
7211	LA5148	2	sediment	-25.3	93.39	0.28	510	25
7212	LA5148	3	charcoal	-11.6	63.38	0.22	3660	25
7213	LA51 48	4	charcoal	-13.1	64.89	0.23	3470	26
7214	LA51 48	5	collagen	-8.9	96.62	0.33	280	27
7215	LA51 48	6	charcoal	-22.8	89.68	0.29	870	28

The charcoal sample was treated with 5% HCl at the temperature 80°C for 1 hour, then it was washed and with deionized water on the fiberglass filter and rinsed with diluted NaOH to remove possible contamination by humic acids. After that the sample was treated with diluted HCL again, washed with deionized water and dried at 60°C.
The sediment sample was treated with 1N HCl to remove any carbonates, after that the samples was filtered on fiberglass filter, washed with deionized water and dried at 105°C.
For accelerator mass spectrometry analysis the cleaned sample was combusted at 900°C in evacuated / sealed ampoules in the presence of CuO.
The bone was cleaned by wire brush and washed, using ultrasonic bath. After cleaning, the dried bone was gently crushed to small fragments. The crushed bone was treated with 1N HCl at 4º for 24 hours. The residue was filtered, rinsed with deionized water and under slightly acid condition (pH=3) heated at 80ºC for 6 hours to dissolve collagen and leave humic substances in the precipitate. The collagen solution is then filtered to isolate pure collagen and dried out. The dried collagen was combusted at 575ºC in evacuated/sealed Pyrex ampoule in the present CuO. The carbon dioxide has cryogenically been separated for analyses

The resulting carbon dioxide was cryogenically purified from the other reaction products and catalytically converted to graphite using the method of Vogel *et al*. (1984) Nuclear Instruments and Methods in Physics Research B5, 289-293. Graphite $^{14}C/^{13}C$ ratios were measured using the CAIS 0.5 MeV accelerator mass spectrometer. The sample ratios were compared to the ratio measured from the Oxalic Acid I (NBS SRM 4990). The sample $^{13}C/^{12}C$ ratios were measured separately using a stable isotope ratio mass spectrometer and expressed as $\delta^{13}C$ with respect to PDB, with an error of less than 0.1‰. The quoted uncalibrated dates have been given in radiocarbon years before 1950 (years BP), using the ^{14}C half-life of 5568 years. The error is quoted as one standard deviation and reflects both statistical and experimental errors. The date has been corrected for isotope fractionation.

Sincerely,

Dr.Alexander Cherkinsky

Appendix B: Macrobotanical and Pollen Analyses

Pollen and macro-botanical Analysis of Samples from LA 5148, Lea County, New Mexico

Report Submitted To:
Peter Condon
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Report Submitted By:
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Quaternary Services Technical Report Series
Report Number 2010-005
September, 2010

Introduction

A total of 4 flotation samples, 1 macrobotanical sample, and 5 pollen soil samples were sent for analysis to Quaternary Services. These samples were recovered from a testing project located in Lea County, New Mexico. The site was undated and with no cultural affiliation. The site is located on a low rise, at an elevation of 3450' AMSL, along the eastern edge of Laguna Playa, in Lea County, New Mexico. The vegetation of the area is descrbed as a desert scrub community consisting of Prosopis sp. (Mesquite), Larrea tridentata (Creosote bush), and a variety of grasses.

Methods and Materials

Palynological Extraction

Chemical extraction of pollen samples was conducted at the Palynology Laboratory at Texas A&M University, using a procedure designed for semi-arid Southwestern sediments. The method, detailed below, specifically avoids use of such reagents as nitric acid and bleach, which have been demonstrated experimentally to be destructive to pollen grains (Holloway 1981).

From each pollen sample submitted, 25 grams (g) of soil were sub-sampled. Prior to chemical extraction, three tablets of concentrated *Lycopodium* spores (18,583 marker grains per tablet) were added to each sub-sample. The addition of marker grains permits calculation of pollen concentration values and provides an indicator for accidental destruction of pollen during the laboratory procedure.

The samples were treated with 3 percent Hydrochloric Acid (HCl) overnight to remove carbonates and to release the *Lycopodium* spores from their matrix. After neutralizing the acid with distilled water, the samples were allowed to settle for a period of at least three hours before the supernatant liquid was carefully poured off and discarded . Additional distilled water was added to the supernatant, and the mixture was swirled and then allowed to settle for 10 seconds. The liquid was then carefully poured off and saved in a second beaker. This procedure was repeated a total of three times to ensure that all pollen would be freed from the matrix that remained in the original beaker. The sand and small rocks remaining in the beaker were then discarded. If any clay particles remained in the matrix, the matrix material was placed into a 50 ml centrifuge tube, a solution of Darvan (a detergent) was added and the tube was sonicated in a Delta D-9 Sonicator for no longer than 15 seconds because occasionally, longer sonication can damage some of the most fragile pollen grains. After sonication, the contents of the centrifuge tube were placed in a beaker and the decanting process was repeated three times. We have found that a short sonication will disperse small clods of clay, thus releasing any potential pollen into suspension. All of the saved, suspended fine fraction was decanted through a screen with openings of 150µ. All material passing through the screen was concentrated using centrifugation mesh screen into a second beaker. This procedure, repeated at least three times, removed lighter materials, including pollen grains, from the heavier fractions.

The fine fraction was treated with concentrated (48%)Hydrofluoric Acid (HF) overnight to remove silicates. After completely neutralizing the acid with distilled water, the samples were treated with a concentrated wash of HCl. This procedure removed any potential fluorosilicates that often form during the HF process. The HCl wash was repeated several times until the solution remained clear after centrifugation. The samples were then washed twice in distilled water.

The samples were dehydrated in glacial acetic acid in preparation for acetolysis. Acetolysis solution (acetic anhydride: concentrated sulfuric acid in 9:1 ratio) following Erdtman (1960), was added to each sample. Centrifuge tubes containing the solution were heated in a heating block at 180° F for approximately 8 minutes, and then cooled for an additional 8 minutes before centrifugation. Each sample was then washed and removal of the acetolysis solution with glacial acetic acid followed by two washes with distilled water. Centrifugation at 2,000 RPM for 90 seconds dramatically reduced the size of the sample, yet from periodic examination of the residue, did not remove fossil palynomorphs. The samples were dehydrated in glacial acetic acid in preparation for acetolyis. Acetolysis solution (acetic anhydride: concentrated sulfuric acid in 9:1 ratio) following Erdtman (1960), was added to each sample. Centrifuge tubes containing the solution were heated in a boiling water bath for approximately 8 minutes and then cooled for an additional 8 minutes before centrifugation and removal of the acetolysis solution with glacial acetic acid followed by distilled water. Centrifugation at 2,000 RPM for 90 seconds dramatically reduced the size of the sample, yet from periodic examination of the residue, did not remove fossil palynomorphs.

Heavy density separation ensued using zinc bromide ($ZnBr_2$), with a specific gravity of 2.00, to remove much of the remaining detritus from the sample pollen. After 10 minutes of centrifugation at 2,000 RPMs, the light fraction was removed and diluted with 95% ETOH in a ratio of distilled water (10:1) and then concentrated by centrifugation. The samples were then washed repeatedly in distilled water until neutral. The residues were then rinsed in a 5% solution of potassium hydroxide (KOH) for less than one minute which is effective in removing the majority of the unwanted alkaline soluble humates. This was followed by a wash with concentrated HCl, which is essential to remove the remaining dissolved materials that are not water soluble. Next, the samples were washed with distilled water. That process was repeated until the solution was clear.

Although all of the previous procedures will effectively remove most of the unwanted matrix materials, none of these actions seem to have much effect on charcoal, which is inert. Unfortunately, we have yet to discover any procedure that will effectively remove charcoal from pollen samples without harming either the fossil pollen or removing some of it as well.

The residues were rinsed in Ethanol (ETOH) stained with safranin-O, rinsed twice with ETOH, and transferred to 1-dram vials with ETOH. The samples were mixed with a small quantity of glycerine and allowed to stand overnight for evaporation of the remaining ETOH. The storage vials were capped and were returned to TRC Solutions Inc. at the completion of the project.

A drop of the polliniferous residue was mounted on a microscope slide for examination under an 18 X 18 mm cover slip sealed with fingernail polish. The slide was examined using 200X or 100X magnification under an aus-Jena Laboval 4 compound microscope. Occasionally, pollen grains were examined using either 400X or 1,000X oil immersion to obtain a positive identification to either the family or genus level.

Abbreviated microscopy was performed on each sample in which either 20 percent of the slide (approximately four transects at 200X magnification) or a minimum of 50 marker grains were counted. If warranted, full counts were conducted by counting to a minimum of 200 fossil grains. Regardless of which method was used, the uncounted portion of each slide was completely scanned at a magnification of 100X for larger grains of cultivated plants such as *Zea mays* and *Cucurbita,* two types of Cactus (Platyopuntia and Cylindropuntia), and other large pollen types such as members of the Malvaceae, or Nyctaginaceae families. Because corn pollen was very common in many of these samples, corn grains were tabulated during the scans only if an unequal distribution of this taxon on the microscope slide was observed.

For those samples warranting full microscopy, a minimum of 200 pollen grains per sample were counted as suggested by Barkley (1934), which allows the analyst to inventory the most common taxa present in the sample. All transects were counted completely (Brookes and Thomas 1967), resulting in various numbers of grains counted beyond 200. Pollen taxa encountered on the uncounted portion of the slide during the low magnification scan are tabulated separately.

Total pollen concentration values were computed for all taxa. In addition, the percentage of Indeterminate pollen was also computed. Statistically, pollen concentration values provide a more reliable estimate of species composition within the assemblage. Traditionally, results have been presented by relative frequencies (percentages) where the abundance of each taxon is expressed in relation to the total pollen sum (200+ grains) per sample. With this method, rare pollen types tend to constitute less than 1 percent of the total assemblage. Pollen concentration values, provide a more precise measurement of the abundance of even these rare types. The pollen data are reported here as pollen concentration values using the following formula:

$$\mathbf{PC} = \frac{\mathbf{K} * \sum_{p}}{\sum_{L} * \mathbf{S}}$$

Where: PC = Pollen Concentration
K = *Lycopodium* spores added
$\sum_p$ = Fossil pollen counted
$\sum_L$ = *Lycopodium* spores counted
S = Sediment weight

The following example should clarify this approach. Taxon X may be represented by a total of 10 grains (1 percent) in a sample consisting of 1,000 grains, and by 100 grains (1 percent) in a second sample consisting of 10,000 grains. Taxon X is 1 percent of each sample, but the difference in actual occurrence of the taxon is obscured when pollen frequencies are used. The use of "pollen concentration values" are preferred because it accentuates the variability between samples in the occurrence of the taxon. The variability, therefore, is more readily interpretable when comparing cultural activity to noncultural distribution of the pollen rain.

Variability in pollen concentration values can also be attributed to deterioration of the grains through natural processes. In his study of sediment samples collected from a rockshelter, Hall (1981) developed the "1000 grains/g" rule to assess the degree of pollen destruction. This approach has been used by many palynologists working in other contexts as a guide to determine the degree of preservation of a pollen assemblage and, ultimately, to aid in the selection of samples to be examined in greater detail. According to Hall (1981), a pollen concentration value below 1000 grains/gm indicates that forces of degradation may have severely altered the original assemblage. However, a pollen concentration value of fewer than 1000 grains/g can indicate the restriction of the natural pollen rain. Samples from pit structures or floors within enclosed rooms, for example, often yield pollen concentration values below 1000 grains/g.

Pollen degradation also modifies the pollen assemblage because pollen grains of different taxa degrade at variable rates (Holloway 1981, 1989; Holloway and Bryant 1983). Some taxa are more resistant to deterioration than others and remain in assemblages after other types have deteriorated completely. Many commonly occurring taxa degrade beyond recognition in only a short time. For example, most (ca. 70 percent) Angiosperm pollen has either tricolpate (three furrows) or tricolporate (three furrows each with pores) morphology. Because surfaces erode rather easily, once deteriorated, these grains tend to resemble each other and are not readily distinguishable. Other pollen types (e.g. Cheno-am) are so distinctive that they remain identifiable even when almost completely degraded.

Pollen grains were identified to the lowest taxonomic level whenever possible. The majority of these identifications conformed to existing levels of taxonomy with a few exceptions. For example, Cheno-am is an artificial, pollen morphological category which includes pollen of the family Chenopodiaceae (goosefoot) and the genus *Amaranthus* (pigweed) which are indistinguishable from each other (Martin 1963). All members are wind pollinated (anemophilous) and produce very large quantities of pollen. In many sediment samples from the American Southwest, this taxon often dominates the assemblage.

Pollen of the Asteraceae (Sunflower) family was divided into four groups. The high spine and low spine groups were identified on the basis of spine length. High spine Asteraceae contains those grains with spine length greater than or equal to 2.5µ while the low spine group have spines less than 2.5µ in length (Bryant 1969; Martin 1963). *Artemisia* pollen is identifiable to the genus level because of its unique morphology of a double tectum in the mesocopial (between furrows) region of the pollen grain. Pollen grains of the Liguliflorae are also distinguished by their fenestrate morphology. Grains of this type are restricted to the tribe Cichoreae which includes such genera as *Taraxacum* (dandelion) and *Lactuca* (lettuce).

Pollen of the Poaceae (Grass) family are generally indistinguishable below the family level, with the single exception of *Zea mays*, identifiable by its large size (ca 80ų), relatively large pore annulus, and the internal morphology of the exine. All members of the family contain a single pore, are spherical, and have simple wall architecture. Identification of non-corn pollen is dependent on the presence of the single pore. Only complete or fragmented grains containing this pore were tabulated as members of the Poaceae.

Clumps of four or more pollen grains (anther fragments) were tabulated as single grains to avoid skewing the counts. Clumps of pollen grains (anther fragments) from archaeological contexts are interpreted as evidence for the presence of flowers at the sampling locale (Bohrer 1981). This enables the analyst to infer possible human behavior.

Finally, pollen grains in the final stages of disintegration but retaining identifiable features, such as furrows, pores, complex wall architecture, or a combination of these attributes, were assigned to the Indeterminate category. The potential exists to miss counting pollen grains without identifiable characteristics. For example, a grain that is so severely deteriorated that no distinguishing features exist, closely resembles many spores. Pollen grains and spores are similar both in size and are composed of the same material (Sporopollenin). So that spores are not counted as deteriorated pollen, only those grains containing identifiable pollen characteristics are assigned to the Indeterminate category. Thus, the Indeterminate category contains a minimum estimate of degradation for any assemblage. If the percentage of Indeterminate pollen is between 10 and 20 percent, relatively poor preservation of the assemblage is indicated, whereas Indeterminate pollen in excess of 20 percent indicates severe deterioration to the assemblage.

In those samples where the total pollen concentration values are approximately at or below 1000 grains/g, and the percentage of Indeterminate pollen is 20 percent or greater, counting was terminated at the completion of the abbreviated microscopy phase. In some cases, the assemblage was so deteriorated that only a small number of taxa remained. Statistically, the concentration values may have exceeded 1000 grains/gm. If the species diversity was low (generally these samples contained only pine, Cheno-am, members of the Asteraceae (Sunflower) family and Indeterminate category, counting was also terminated after abbreviated microscopy even if the pollen concentration values slightly exceeded 1000 grains/g.

Flotation Methodology

The entire sample submitted for analysis was treated using water separation by personnel of TRC solutions Inc. The initial volume of material was measured and recorded and then screened to remove the larger particles. The screened material was examined separately but was not subject to water separation. The material passing through this screen was placed in a modified flotation device for the physical flotation. The light fraction was collected and dried separately. After drying completely, the material was placed in labelled zip-loc bags prior to analysis.

The contents of the light fraction were measured (volume) and then examined using a Meiji stereoscopic zoom microscope (7X-45X magnification). Wood charcoal specimens were examined using a modification of the snap method of Leney and Casteel (1975) in order to expose fresh transverse surfaces. These are necessary since often soil particles fill the vessel elements of the wood charcoal, obscuring the characteristics necessary for identification. Identifications of wood charcoal and seed materials were based on published reference materials (Martin and Barkley 1961, Montgomery, 1977, Panshin and DeZeeuw 1980, Schopmeyer 1974), as well as comparisons with modern reference specimens.

Results

The results of the flotation samples are presented in Table 1, while the pollen results are contained in Table 2. The macrobotanical samples were collected from features within the site, while the pollen was taken from 2 trenches. Samples 1-3 were taken from Trench 6 while samples 4-5 were taken from Trench 1. The individual results are present below by feature an unit.

Feature 2

Bag 21 was taken from this pithouse floor from unit 1 from within this feature. Approximately 10 mls of material was recoverd. Charcoal fragments too small to identify were present along with *Prosopis* sp. charcoal. A single charred grass stem was also recovered. Uncharred plant debris was also present in this sample.

Feature 3

Bag 18 was taken from this post mold feature from Unit 2. The charcoal was very small and consisted of charcoal fragments too small to identify, along with charcoal that compared favorably to *Prosopis* sp. Only a very small amount (3 ml) of light fraction was obtained.. Uncharred plant debris was also present in this sample.

Feature 6

The remaining 3 samples all were collected from this Feature 6 location. Bag 49-1 was taken from TU 3 from the south half and was taken from level 3. Charcoal fragments too small to identify were present along with *Prosopis* sp. charcoal. Uncharred plant debris was also present in this sample.

Sample 49-2 was taken from TU3 from Strat I, level A6 and contained charcoal fragments too small to identify, and *Prosopis* sp. charcoal. Uncharred plant debris, insect remains and snail shells were also present in this sample.

A suspected seed was recovered from unit 6S/3E-G. Upon microscopic examination, this is likely not a seed. Based on the internal anatomy of the object, this item resembles a type of shelf-fungus common in the area.

Pollen Columns
Trench 1

Two soil samples were taken from Trench 1, and I am assuming that these are in stratigraphic sequence. Data on this will be forthcoming. The pollen assemblages from this trench were extremely poorly preserved and contained minimal to no pollen. Sample 4 (upper) contained 265 grains/gm total pollen concentration values. *Pinus edulis* type pollen (71 grains/gm) was present in trace amounts only. Poaceae and low spine Asteraceae (18 grains/gm each) were present in very low amounts, while Cheno-am, Indeterminate, and an unknown tricolporate were present in amounts only slightly higher.

Sample 5 was taken from below sample 4 and contained no pollen. A single grain of *Artemisia* (4.42 grains/gm) was observed in the low magnification scan of the slide. This was the only pollen grain recovered.

Trench 6

Trench 6 contained 3 samples. Sample 1, contained a high concentration value of pollen at 2551 grains/gm. This was also the only sample producing a pollen count in excess of 200 grains. *Pinus edulis* type pollen (162 grains/gm) was present in trace amounts only. *Juniperus* and an unknown triporate grain (12 grains/gm) contained only single grains and were present in very small to trace amounts. *Ulmus* pollen (46 grains/gm) was present in low amounts. Cheno-am pollen (139 grains/g) was very low along with low amounts of Poaceae and pollen clumps of Chenopodium (23/gm). High spine (46 grains/gm), and low spine (81 grains/gm) Asteraceae were moderate to high, and *Artemisia* (1881 grains/gm) was present in very high amounts. Small amounts of *Ephedra* (35 grains/gm) and the unknown triporate (12 grains/gm) were also present. Interestingly, the pollen of Fabaceae (46 grains/gm) was also present. These grains were somewhat larger and had a very pronounced exerted pore.

Sample 2 contained 5541 grains/gm contained the highest pollen concentration value recovered from this site. *Pinus edulis* type (338 grains/gm) was present in very low amounts with trace to low amount of *Pinus ponderosa*.(135 grains/gm). *Juniperus* (34 grains/gm), and *Quercus* (68 grains/gm) were present in low to trace amounts. Cheno-am pollen (2635 grains/gm) dominated the assemblage along with high amounts (237 grains/gm) of Poaceae, high spine Asteraceae (1216 grains/gm), and *Artemisia* (270 grains/gm). Only a small amount of low spine Asteraceae (68 grains/gm) was present. A moderate amount of *Ephedra* (68 grains/gm) was present in addition to Brassicaceae (68 grains/gm), Fabaceae, *Eriogonum*, and *Sphaeralcea* (34 grains/gm each).

Sample 3 contained only 212 grains/gm total pollen concentration values and was based on a pollen sum of only 16 grains. *Pinus edulis* type pollen (27 grains/gm) was present in trace amounts only with very small amounts of Cheno-am (119 grains/gm), Poaceae (13 grains/gm), low spine Asteraceae and *Artemisia* (27 grains/gm each).

Discussion

The flotation remains were fairly small, yet consistent. The majority of the charcoal consisted of small fragments which were too small for a positive identification. Those that were identified consisted of Prosopis sp., which is consistent with the modern vegetation of the site area. A single charred grass stem was also recovered from the pithouse floor from Feature 2. This may have been used as fuel or, in construction of the pithouse but with only a single sample recovered, it is not possible to determine which.

Pollen samples

The two samples (4 and 5) taken from Trench 1 were fairly poorly preserved. Sample 5, presumably deeper, contained no pollen. The upper sample from this trench contained a pollen sum of only 15 grains and Indeterminate pollen accounted for 20% of the assemblage. *Pinus*, Poaceae, Cheno-am and low spine Asteraceae were present in the assemblage. The assemblage appeared so deteriorated that no useable information could be discerned.

Pinus pollen was only rarely present in these assemblages. In almost all cases, *Pinus edulis* type pollen was present in trace amounts and the pollen concentration values never exceeded very low estimations. The consistently low pollen concentration values for this taxon suggest that it was deposited via long distance transport. Pollen of *Pinus* is produced in structures called strobili, which are located in clusters of 8-10+ on the terminal branch ends. Each strobilus produces in excess of 1 million pollen grains, specifically structured for wind pollination. Thus, it is not surprising to recover *Pinus* pollen from areas in which no *Pinus* is growing. I suspect that *Pinus* pollen is derived from higher elevation areas located to the Northwest and Southwest of the site, and probably at some distance.

The assemblages from Trench 6 were only slightly better preserved. The upper 2 levels contained total pollen concentration values of 2551 grains/gm and 5541 grains/gm which is fairly good. The lower most sample contained a total pollen concentration value of only 212 grains/gm which is very low.

The lowest sample (#3) contained *Pinus edulis* type, Poaceae, Cheno-am, low spine Asteraceae and *Artemisia*. This is consistent with a desert scrub vegetational community as described for site LA 5148. Sample 1, which contained the highest pollen sum, was clearly dominated by *Artemisia* pollen. While present in low pollen concentration values, the presence of Cheno-am, Poaceae, and both high and low spine Asteraceae, suggest the presence of a desert scrub vegetational component. The much higher *Artemisia* component from this sample suggests a sagebrush component not recognized in the other poorly preserved assemblages.

Ulmus and Fabaceae pollen were also present from this upper level. *Ulmus*, is not native to this area of New Mexico and the U.S.D.A. Plants Database (U.S.D.A. 2010) records no presence of Ulmus within Lea County, New Mexico, although it is present in Chavez and Eddy Counties, both adjacent to Lea County. Species of *Ulmus* were introduced historically during the early portion of the 20th century as shade trees, and the pollen may have been deposited from several of the small towns etc where these are present. The pollen grains were in excellent shape and I suspect, that whatever their origin, they are more recent to modern in age.

Fabaceae pollen was also present and this was a rather large grain, with pronounced extended pores. While many members of the Fabaceae look similar, this grain possessed several characteristics of the cultivated forms. While I cannot state with any degree of certainty that these grains belong to *Phaseolus* sp., it is interesting to speculate. The grains were also in excellent condition and it is possible that these represent modern deposition from local gardens, etc. There are housing developments fairly close to the site. Again, without age estimates of the sediments, I cannot do any more than speculate.

Sample 2, is clearly dominated by Cheno-am, Poaceae, Low spine Asteraceae, and to a lesser extent, *Artemisia*. This also argues for a desert scrub community. Given the pollen concentration values of these samples, I suspect that the sagebrush may be a more recent development in the area, or at least the dominance of this taxon. However, at present there are no dates or stratigraphic column available and this remains speculative.

Based on the pollen taxa recovered, the question always arises are economic taxa absent from these assemblages because they are truly not present, or, are they present in such small amounts to have been missed during sampling. In order to assess the likelihood of their being missed, the estimated maximum potential concentration values (Dean 1999) of target taxa was computed. Since the entire slide was examined (either by count or low magnification scan of the slide) the estimated number of marker grains per slide was computed by averaging the number of marker grains per transect and multiplying this by the total number of transects examined. Assuming, that the first grain observed on an hypothetical second slide was one of the target taxa, the maximum potential concentration value can be computed. Thus, the number of the fossil grains is one, and the number of marker grains per slide is substituted for the number of marker grains counted in the pollen concentration formula. These data are presented in Table 2 and indicate that the estimated potential pollen concentration values fall between 4.11 and 11.26 grains/gm. Without examining the total of the pollen residues we can never be absolutely sure that target taxa are indeed absent from the assemblage. Given the low estimated potential pollen concentration values however, I conclude that it is more likely that the missing taxa were indeed absent from these assemblages.

Conclusions

The charcoal remains were dominated by *Prosopis* sp., which is consistent with the local vegetation. *Pinus* pollen likely was deposited in these areas via long distance transport. The presence of *Ulmus* pollen, is likely modern deposition from local housing units.

The assemblages suggest a desert scrub vegetational component, and may suggest the development of a sagebrush plant community somewhat more recently. The desert scrub community seems to have persisted during the life of the arehaeological site.

There is some evidence of Fabaceae pollen from the upper sediments of this site but this taxon is a common member of the vegetational communities. The pollen is in excellent shape and resembles the cultivated variety, *Phaseolus* sp. If this is indeed, *Phaseolus*, then it is likely from local gardens.

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Table 1: Flotation and Macro-Identification, LA 5148, Lea County, New Mexico

Bag #	Unit	Structure	Area	Strat	Level	Feature	Type	Period	Age	Material	Light	Charcoal
18	Unit 2					3	post mold	Unknown	Unknown	flot	3	CF; hw-cf. *Prosopis*
21	Unit 1	Pithouse				2	Pithouse floor	Unknown	Unknown	flot	10	CF; *Prosopis*
49-1	TU 3		S 1/2		3	6		Unknown	Unknown	flot	25	CF; *Prosopis*
49-2	TU 3			I	A6	6		Unknown	Unknown	flot	50	CF; 1- *Prosopis*
369	6S 3E-G					6		Unknown	Unknown	seed		

Table 1: Flotation and Macro-Identification, LA 5148, Lea County, New Mexico

Bag #	Unit	Structure	Area	Strat	Level	Feature	Type	Contaminants	Other	Notes
18	Unit 2					3	post mold	ucpd		charcoal very small
21	Unit 1	Pithouse				2	Pithouse floor	ucpd	1-charred grass stem	
49-1	TU 3		S 1/2		3	6		ucpd		
49-2	TU 3			I	A6	6		ucpd, I, S		
369	6S 3E-G					6			fungal- resembles shelf fungus	

Table 2: Results of Pollen Ana;ysis, LA 5148, Lea Country, New Mexico

Bag #	Cat#	Trench	Age	*Pinus*	*P. pond.*	*P. edulis*	*Juniperus*	*Quercus*	*Ulmus*	Fabaceae	Eriogonum	Brassicaceae	Poaceae	Cheno-am
Raw Pollen Counts														
sample 1	18	6		14		14	1		4	4			2	12
sample 2	21	6		14	4	10	1	2		1	1	2	7	78
sample 3	49-1	6		2		2							1	9
sample 4	49-2	1		4		4							1	3
sample 5	369	1												
Concentration Values														
sample 1	18	6		162	0	162	12	0	46	46	0	0	23	139
sample 2	21	6		473	135	338	34	68	0	34	34	68	237	2635
sample 3	49-1	6		27	0	27	0	0	0	0	0	0	13	119
sample 4	49-2	1		71	0	71	0	0	0	0	0	0	18	53
sample 5	369	1												

Table 2: Results of Pollen Ana;ysis, LA 5148, Lea Country, New Mexico

Bag #	Cat#	Cheno-am af.	Aster. hs.	Aster. ls	*Artemisia*	*Ephedra*	Indeterminate	unk triporate	unk tricolporate	*Sphaeralcea*
Raw Pollen Counts										
sample 1	18	2	4	7	163	3	4	1	0	
sample 2	21		2	36	8	2	6		3	1
sample 3	49-1			2	2					
sample 4	49-2			1			3		3	
sample 5	369									
Concentration Values										
sample 1	18	23	46	81	1881	35	46	12	0	0
sample 2	21	0	68	1216	270	68	203	0	101	34
sample 3	49-1	0	0	27	27	0	0	0	0	0
sample 4	49-2	0	0	18	0	0	53	0	53	0
sample 5	369									

Table 2: Results of Pollen Ana;ysis, LA 5148, Lea Country, New Mexico

Bag #	Cat#	Sum	Total	marker	% Indeterminate	trans	tot trans	mark/slide	*Lycopodium* added	Weight
Data										
sample 1	18	221	2551	161	1.81	8	22	442.75	37166	20
sample 2	21	164	5541	55	3.66	7	21	165.00	37166	20
sample 3	49-1	16	212	140	0.00	6	20	466.67	37166	20
sample 4	49-2	15	265	105	20.00	6	24	420.00	37166	20
sample 5	369			113	0.00	4	16	452.00	37166	20

Table 2: Results of Pollen Ana;ysis, LA 5148, Lea Country, New Mexico

Bag #	Cat#	*Sphaeralcea*	Cactaceae	Fabaceae	*Artemisia*	Max. Potential Concentration
		Based on Counts and Low Magnification Scan of the Slide				
Raw Pollen Counts						
sample 1	18	1		5		
sample 2	21		1			
sample 3	49-1					
sample 4	49-2				1	
sample 5	369					
Concentration Values						
sample 1	18	4.20	0.00	20.99	0.00	4.20
sample 2	21	0.00	11.26	0.00	0.00	11.26
sample 3	49-1	0.00	0.00	0.00	0.00	3.98
sample 4	49-2	0.00	0.00	0.00	4.42	4.42
sample 5	369					4.11

Appendix C: Diatom Analysis

Paleoenvironmental Analysis of Diatoms and Associated Microfossils from Sediments at the Laguna Plata Archaeological Site, LA5148, Lea County, New Mexico

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INTRODUCTION

This study focuses on diatoms preserved in sediments collected from the Laguna Plata archaeological site in Lea County, New Mexico. The objective is to use the ecological preferences of individual diatom species and associated microorganisms preserved in sediments associated with the site, to provide information about the paleoenvironment and possibly resource procurement. Diatoms are unicellular, photosynthetic algae distinguished by the possession of a silica cell wall. They can be found living in a wide variety of natural and man-made terrestrial and aquatic habitats, including seeps, wet walls, dry and damp soil, springs, streams, creeks, sloughs, lakes, playas, rivers, ponds, marshes, lagoons, salt works, estuaries, bays, and oceans. Most are cosmopolitan - found in many parts of the world under similar environmental conditions, and many species have predictable environmental requirements and pollution tolerances that directly effect diatom species composition.

Diatoms, which often can be readily identified to species, are the most taxonomically diverse and well-studied algal group found in streams and lakes. A large and growing body of information exists on the range of ecological tolerance of many common taxa (see Winsborough, 2010) for summary). The Laguna Plata sediments are young enough that information on the ecological preferences and limitations of living diatom communities can be applied. Large diatom data sets from various parts of the world have shown that living diatom communities provide reliable analogs for estimates of past salinity, depth, trophic (nutrient) level, pH, habitat, seasonality, and (indirectly) climate. Since diatoms are sensitive to so many physical and chemical parameters, and are often found in large numbers in sedimentary deposits, they are well-suited for use in paleoenvironmental reconstruction. An extensive diatom study of paleolakes and draws on the Southern High Plains to the east (Winsborough, 1995) covering the past 12,000 years showed that a diverse diatom community has existed in the area since the Pleistocene, and that it has responded by adapting to changes in local environmental conditions.

Laguna Plata is one of four large playas in a subsidence basin formed by the collapse of cavernous groundwater conduits. Laguna Plata is an alkali salt lake at the present time, fed by at least 12 springs (Bullock, 2001). The lake was originally a freshwater lake fed by springs from the aquifer. Playa lakes characteristically have a water level that fluctuates seasonally and they become increasingly saline as drying progresses. In the case of Laguna Plata and the three other interconnected depressions in the subsidence basin, drainage is internal, and salts accumulate. Eight samples were submitted to Winsborough Consulting for analysis and this report contains the results of this analysis.

METHODS

Sediment samples were cleaned of organic material and soluble minerals in preparation for microscopic analysis by boiling first in hydrogen peroxide and then in nitric acid. The oxidized, decalcified material was rinsed repeatedly until a pH of about 7 was reached. A few drops of the cleaned material was air-dried onto 22x22mm cover glasses and mounted onto glass slides using NAPHRAX© a synthetic resin with a high index of refraction, developed to aid in resolving the details of diatom cell wall morphology. Two slides of each sample were scanned in their entirety at x600, and all diatoms, diatom fragments and associated microorganisms were recorded. (Table 1). Diatom identifications are based on Witkowski, 2000, Krammer, 2002, Gasse, 1986. Photomicrographs were taken with a Nikon D80 on an Olympus BH2.

RESULTS

Diatoms or at least diatom fragments were found in all but one sample. Sample 3 was barren of any microfossils. Thirteen diatom forms were found in the 8 samples and of these 10 could be identified to species. The other forms were not complete enough or oriented too poorly to be identified further than to genus. In some instances the fragments could be identified as diatoms but were too small for more precise identification (figs. 14,18). A total of 29 diatoms and diatom fragments were found in the eight samples. Some of the identifications include 'cf' in the name to indicate that the identifications can only be considered tentative due to the fragmented nature or poor orientation of the specimens.

DISCUSSION

The ecology of the 10 species identified is summarized on Table 2. This ecological list includes the algal attributes described for many diatoms by Porter (2008), and those found in Witkowski, 2000, Krammer, 2002, Gasse, 1986. The autecological and community characteristics listed in the various studies show that there is some redundancy and a certain degree of disagreement among the investigations due to differences in sampling and analyzing protocols, but for the most part there is reasonable agreement. Differences can often be related to the methods of collection, taxonomic precision, purpose of the investigation and available funding.

Porter *et al.*, (2008) used periphyton data collected between 1993-2001 from 976 streams and rivers by the U.S. Geological Survey's NAWQA program to evaluate national and regional relations of periphyton with water chemistry. They explored the efficacy of algal metrics for assessing nutrient and organic enrichment in flowing waters and determined whether algal-metric values differ significantly among undeveloped and developed land-use classifications. The results of their study were that algal metrics having significant positive correlations with nutrient concentrations included indicators of trophic condition, organic enrichment, salinity, motility and taxa richness. Another result of their study was that the abundance of diatoms associated with high concentrations of dissolved oxygen was negatively correlated with both nitrogen and phosphorus concentrations. These concepts form the basis of this discussion.

The diatoms found during this study include aquatic, free-floating planktonic (suspended in the water column) species, and benthic species associated with sediment, pebbles, stones, sand, microbial mats, drifting mats of filamentous algae, and rooted vegetation on the floor of a stream or lake. Motile benthic forms glide through mud, and others are firmly attached to macrophytes or larger algae, rocks, sand, and attached to molluscs, turtles and fish. The only planktonic diatoms found are the *Aulacoseira* taxa (figs. 2,3,12). All the other diatoms are found in various benthic or aerial habitats.

This is a depauperate assemblage when compared to the number of species in a typical modern stream or lake sample. There are several reasons why the diatom density is so low. If the diatoms grew where they were found then there was a high sedimentation rate that diluted the diatoms with, presumably, wind-blown sediment. Another possibility is that the diatoms were picked up from a dry lake bed and transported to the site by wind. A third possibility is that the diatoms were carried to where they were found along with the collection of water for domestic use. The ecological requirements and tolerances of the ten diatom species suggest that they grew under different environmental conditions of substrate and salinity. Since 8 of the ten diatoms are alkaliphilous, living in a pH above 7, and the other 2 are pH indifferent, the pH of the water ranged from about 7 to over 8 depending on dilution. Some taxa, such as *Cymbella excisa* Kützing (figs. 10,11), *Encyonema delicatula* Kützing (fig. 13), *Pinnularia appendiculata* (Agardh) Cleve (fig. 1), and *Reimeria sinuata* (Gregory) Kociolek & Stoermer (figs. 4,5), are found typically in dilute, clean, slightly alkaline waters such as are found in spring-fed streams fed by a limestone aquifer. They are found in habitats that are low in nitrogen and phosphorus, sensitive to pollution and do not tolerate eutrophic or degraded conditions. The greatest number of diatom taxa found in any one sample is only five.

Another diatom component that includes *Amphora veneta* Kützing (fig. 17), *Aulacoseira granulata* variety *angustissima* (O. Müller) Simonsen (fig. 12), *Nitzschia* cf. *clausii* Hantzsch (fig. 16), and *Nitzschia* cf. *vitrea* Norman (fig. 8) lives in water with elevated salts, such as freshwater with elevated salt concentrations to brackish water habitats. The ions were probably a combination of carbonate, sulfate and chloride depending on degree of concentration. These diatoms tolerate high levels of nitrogen and phosphorous and eutrophic conditions and were probably living in a saline lake setting. Diatoms have variable responses to elevated ion concentrations. Some diatoms are sensitive to salts and others thrive on elevated concentrations. Some diatoms favor one particular ion such as carbonate, sulfate, or chloride. Diatom salinity classification schemes (Denys and De Wolf 1999, Fritz *et al.* 1999, Admiraal 1984) show that diatoms replace each other with increasing salinity and this series of species replacements along the salinity gradient makes diatoms powerful indicators of chemical change driven by changes in hydrology and climate.

Two more species, *Nitzschia amphibia* Grunow (fig. 6), and *Surirella* cf. *angusta* Kützing (fig. 15) are found in streams as well as lakes but are also tolerant of pollution and variable salinity. The *Nitzschia amphibia* was unbroken suggesting that it grew close to where it was found. These diatoms may simply reflect seasonal fluctuations in stream flow. Three of the species, *Encyonema* cf. *delicatula* Kützing (fig. 13), *Nitzschia amphibia* Grunow, and *Pinnularia appendiculata* (Agardh) Cleve are also found in aerial damp or dry habitats such as moss or sediments that are occasionally dampened. The benthic, aquatic and aerial habitats often overlap in areas with seasonally limited rainfall and fluctuating water levels. Available substrate also plays a role in the kinds of diatoms that can live in a habitat. The epiphytic forms need a solid substrate, usually a larger alga or aquatic macrophyte, or a rock or pebble. The epipelic forms crawl among sand and silt particles or among detritus in a thick algal mat.

In terms of archaeological relevance, if the sediment was collected from an occupation surface the spring and stream diatoms could have been transported to the site from a nearby water source with water used for cooking and other domestic purposes. They were for the most part unbroken and do not reflect much mechanical transport and erosion. A liter of water collected from a stream will most probably have a substantial number of diatoms in it. The saline lake diatoms could represent high water stands or aeolian transport.

There were several other kinds of microfossils on the slides, besides diatoms, and these were recorded and photographed on the chance that they may contain useful paleoecological information or possible evidence of resource procurement. These include pollen (figs. 22-38), phytoliths (figs. 39,40), unidentified plant material (figs. 20,21), chrysophyte cysts (fig. 19). Pollen was recorded because it can provide evidence of plants used as a subsistence or supplemental food source, as well as those used for other purposes such as grass or reeds used for baskets, medical plants and plant material used for dyes or pigments (Bullock, 2001). The pollen records are by no means meant to be a comprehensive pollen analysis of the sample, only to provide additional information to the palynologist. At least one photomicrograph of each kind of pollen is provided.

Chrysophyte cysts (also called statospores or stomatocysts) are used to track changes in paleosalinity. Cysts are resting stages of members of the algal class Chrysophyceae and the wall of the statospore is siliceous. They are found primarily in freshwater lakes that are low in nutrients. The cysts allow the algae to survive droughts and other adverse conditions. There were not enough cysts in these samples to imply anything other than that there was water nearby that may have been low in nutrients and dried out.

This investigation shows that it is possible to find diatoms in sediments associated with the Laguna Plata site. Future studies should include analyses of diatom collections from modern spring, stream and lake habitats in the vicinity of the site. These data can be used to identify environmental changes associated with long term maturation of the spring-lake system including the effects of subsidence due to local subsurface hydrological processes.

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TABLE 1

ABUNDANCE OF DIATOMS AND OTHER MICROFOSSILS IN SEDIMENTS FROM THE LAGUNA PLATA ARCHAEOLOGICAL SITE (LA5148)

Sample number:	1	2	3	4	5	6	7	8
Amphora veneta Kützing							2	
Aulacoseira granulata var. angustissima (O. Müller) Simonsen				1				
Aulacoseira sp.						3		1
Cymbella excisa Kützing						1		
Cymbella sp.						4		
Encyonema delicatula Kützing				1				
Nitzschia amphibia Grunow						1		
Nitzschia cf. clausii Hantzsch					1			
Nitzschia vitrea Norman						1		
Pinnularia appendiculata (Agardh) Cleve								1
Reimeria sinuata (Gregory) Kociolek & Stoermer		5					1	
Surirella angusta Kützing	1							
Surirella ap.								
Unidentified diatom fragments				1		3		1
Total diatoms and diatom fragments	1	5		3	1	13	3	3
Pollen		1		9		8	3	
Phytoliths						5		
Unidentified plant material						2		
Chrysophyte cysts (statospores)							2	2

Key to sample provenience:
1. Salina floor
2. Road cut-bank lakebed, zone 3, 43cm
3. Road cut-bank lakebed, zone 4, 60cm
4. Trench 1, zone 5, 135 cm
5. Trench 1, zone 14, 242cm
6. Trench 6, zone 3
7. Trench 6, zone 5
8. Trench 6, zone 8

TABLE 2

ECOLOGY OF DIATOMS FOUND IN THE LAGUNA PLATA SEDIMENTS

Amphora veneta Kützing	benthic, eutrophic, indicator of high total nitrogen and phosphorus, alpha-meso/polysaprobous very tolerant of high organic nitrogen, high nutrient and organic enrichment, extremely degraded conditions, moderate oxygen concentrations, alkaliphilous, brackish-freshwater, specific conductivity optimum high, benthic, non-motile
Aulacoseira granulata var. angustissima (O. Müller) Simonsen	planktonic, optimal growth in shallow lakes, tolerates highly turbid water, medium conductivity 500-1200 μScm^{-1}, alkaliphilous, pH around 8-8.5, sodium rich water, eutrophic, beta-mesosaprobous, tolerates high organic nitrogen, sensitive to nutrient and organic enrichment, tolerates moderate oxygen concentrations, fresh-brackish water, nonmotile
Cymbella excisa Kützing	benthic, epilithic and epiphytic in stagnant and flowing water, mesotrophic, medium conductivity, eutrophic, indicator of low nitrogen,

	beta-mesosaprobous, sensitive to nutrient and organic enrichment, oligosaprobous, high oxygen concentrations, sensitive to pollution, alkaliphilous, fresh-brackish water, low chloride optimum, non-motile
Encyonema cf.*delicatula* Kützing	benthic, attached, oligotrophic, indicator of low total and organic nitrogen and phosphorus, oligosaprobous, sensitive to nutrient and organic enrichment, high oxygen concentrations, alkaliphilous, freshwater, less than 100 mg/l chloride, less than 0.2ppt salinity, benthic, non-motile, mainly aquatic, also regularly occurs in wet places, carbonate buffered, high conductivity water
Nitzschia amphibia Grunow	benthic and opportunistically planktonic, epipelic, in mud of freshwater lakes and streams, oligohalobous but tolerates higher salt content of different ionic ratios, fresh-brackish water, alkaliphilous to alkalibiontic, pH optimum 8.5 and slight fluctuations in osmotic pressure, eurythermal and can live in hot springs, indicator of high total nitrogen and phosphorus, high organic nitrogen, alpha-mesosaprobous, somewhat to very tolerant of highly degraded conditions, non-motile, sometimes occurs in wet, places that are not submerged
Nitzschia cf. clausii Hantzsch	benthic, non-motile, brackish water, estuaries, inland waters with high conductivity, oxygen-rich fresh water, pH around 8, alkaliphilous, alpha-mesosaprobous, mesohalobous, tolerates high organic nitrogen, tolerates degraded conditions, fairly high oxygen concentrations
Nitzschia cf. *vitrea* Norman	benthic, motile, brackish-waters of marine coasts and inland saline waters, high calcium, alkaline lakes, hot springs, eutrophic, high conductivity, mesohalobous, alkaliphilous, alpha-mesosaprobous
Pinnularia appendiculata (Agardh) Cleve	aquatic, benthic and aerial, motile, on moss, acidophilous, to pH indifferent, pH optimum about 6.5-6.8, low calcium water, also in weakly alkaline water, oligo-mesohaline water, broad temperature range, oligosaprobous, low organic nitrogen, always high oxygen, freshwater, low conductivity
Reimeria sinuata (Gregory) Kociolek & Stoermer	benthic, epipelic or epiphytic in slowly running water, oligohalobous, pH indifferent, mesotrophic, low total nitrogen and phosphorus, beta-mesosaprobous, high oxygen, sensitive to nutrient and organic pollution, always high oxygen, circumneutral pH, fresh-brackish water, low chloride optimum
Surirella cf. *angusta* Kützing	benthic in streams, rivers and swamps, motile, fairly high oxygen content, moderate conductivity, abundant in very eutrophic water and water polluted by cattle, epiphytic, epipelic, epilithic, oligohalobous, alkaliphilous, pH optimum about 7.5 but grows in slightly acid water also, indicator of high nitrogen and phosphorus, beta-mesosaprobous, tolerates high organic nitrogen, nutrient and organic enrichment, fresh-brackish, low chloride optimum

Glossary of terms used (after Van Dam et al., 1994 and Round, 1981):

pH
circumneutral (mainly occurring at pH-values about 7)
alkaliphilous (mainly occurring at pH >7)
alkalibiontic (exclusively occurring at pH >7)
indifferent (no apparent optimum)

Salinity

	Cl^- (mg/L)	Salinity (%)
fresh	<100	<0.2
fresh brackish	<500	<0.9
brackish fresh	500-1000	0.9-1.8

brackish	1000-5000	1.8-9.0

mesohalobous = brackish water form 500-30,00 mg/l Cl

Oxygen requirements

continuously high (about 100% saturation)
fairly high (above 75% saturation)
moderate (above 50% saturation)

Saprobity

	Oxygen saturation (%)	BOD_5^{20} (mg/L)
oligosaprobous	>85	<2
β-mesosaprobous	70-85	2-4
α-mesosaprobous	25-70	4-13
α-meso-/polysaprobous	10-25	13-22
polysaprobous	<10	>22

Trophic state

oligotrophic- nutrient poor
mesotrophic-moderate nutrient concentrations
eutrophic- nutrient rich

Substrate

epilphytic- attached to plants or other algae
epilithic- on rocks
epipelic- in mud
aerial- habitats that are not submerged, such as soil, moss, wet walls and boulders
aquatic- submerged

Figure captions for Laguna Plata photomicrographs

Scale bars are 10 µm long. All photomicrographs are taken at x1000 unless noted otherwise.

Plate 1:

1. *Pinnularia appendiculata* (Agardh) Cleve, sample 8, trench 6, zone 8.
2. *Aulacoseira* sp., sample 8, trench 6, zone 8.
3. *Aulacoseira* sp., sample 6, trench 6, zone 3
4. *Reimeria sinuata* (Gregory) Kociolek & Stoermer, sample 2, road cut-bank lakebed, zone 3, 43cm
5. *Reimeria sinuata* (Gregory) Kociolek & Stoermer, sample 2, road cut-bank lakebed, zone 3, 43cm
6. *Nitzschia amphibia* Grunow, sample 6, trench 6, zone 3
7. *Cymbella* sp., sample 6, trench 6, zone 3
8. *Nitzschia* cf. *vitrea* Norman, sample 6, trench 6, zone 3
9. Cymbella sp., sample 6, trench 6, zone 3
10. *Cymbella excisa* Kützing, (upper valve), sample 6, trench 6, zone 3
11. *Cymbella excisa* Kützing, (lower valve), sample 6, trench 6, zone 3

Plate 2:

12. *Aulacoseira granulata var. angustissima* (O. Müller) Simonsen, sample 4, trench 1, zone 5, 135 cm
13. *Encyonema* cf. *delicatula* Kützing, sample 4, trench 1, zone 5, 135 cm
14. Diatom fragment, sample 8, trench 6, zone 8
15. *Surirella* cf. *angusta* Kützing, Salina floor
16. *Nitzschia cf. clausii* Hantzsch, sample 5, trench 1, zone 14, 242cm
17. *Amphora veneta* Kützing, sample 7, trench 6, zone 5
18. Diatom fragment, sample 7, trench 6, zone 5
19. Chrysophyte cyst, sample 7, trench 6, zone 5
20. Plant material, sample 6, trench 6, zone 3

Plate 3:

21. Plant material, sample 6, trench 6, zone 3
22. Pollen, low focus, sample 6, trench 6, zone 3
23. Pollen, same grain, high focus, sample 6, trench 6, zone 3
24. Pollen, x400, sample 6, trench 6, zone 3
25. Pollen, sample 6, trench 6, zone 3
26. Pollen, sample 4, trench 1, zone 5, 135 cm

Plate 4:

27. Pollen cluster, x400, sample 4, trench 1, zone 5, 135 cm
28. Pollen, portion of fig. 27, sample 4, trench 1, zone 5, 135 cm
29. Pollen, sample 4, trench 1, zone 5, 135 cm
30. Pollen, sample 7, trench 6, zone 5

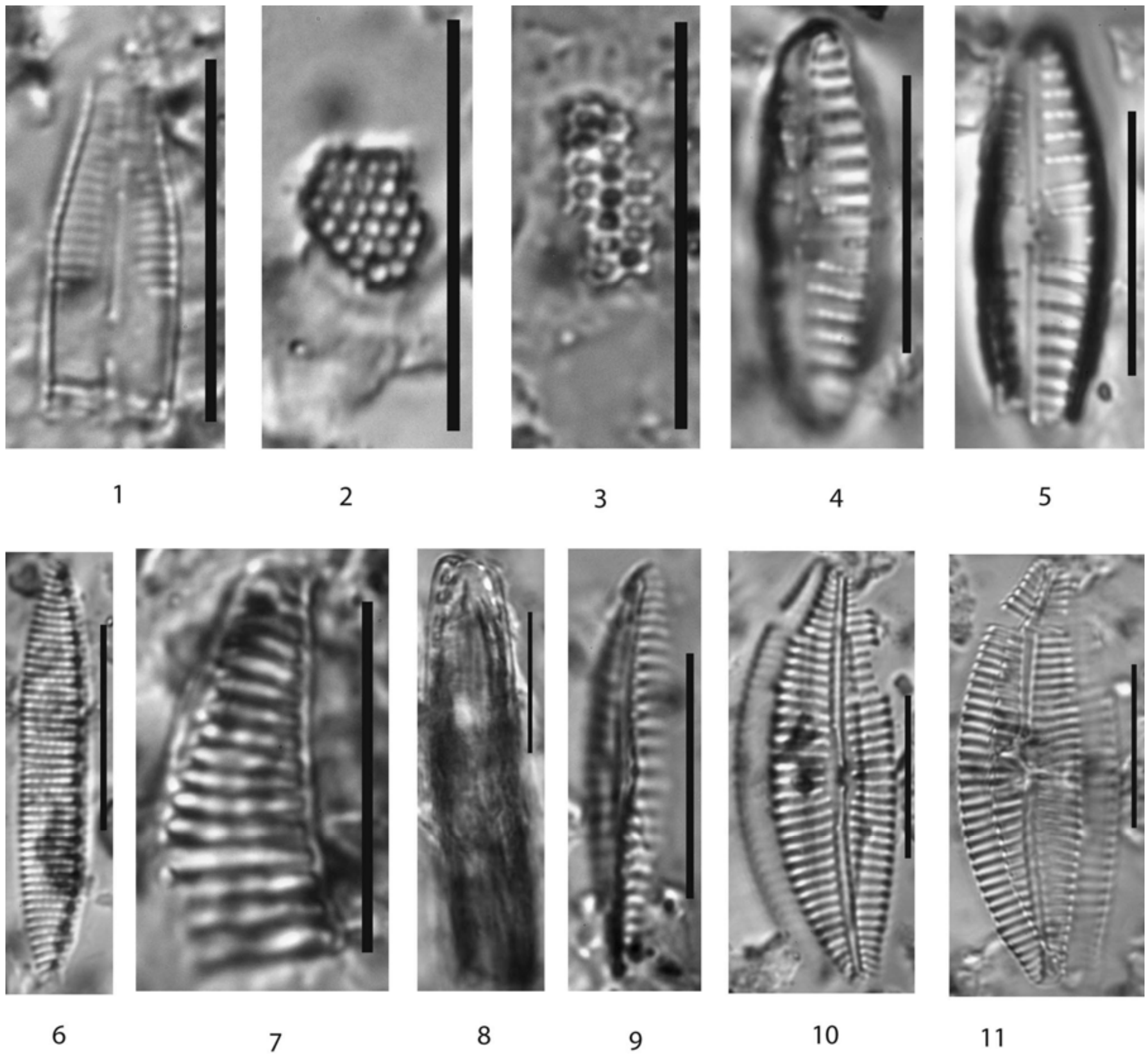
Plate 5:

31. Pollen, x400, sample 6, trench 6, zone 3
32. Pollen, x400, sample 6, trench 6, zone 3
33. Pollen, sample 4, trench 1, zone 5, 135 cm
34. Pollen, sample 7, trench 6, zone 5
35. Pollen, sample 6, trench 6, zone 3

Plate 6:

36. Pollen, sample 6, trench 6, zone 3
37. Pollen, sample 4, trench 1, zone 5, 135 cm
38. Pollen, sample 4, trench 1, zone 5, 135 cm

39. Phytolith, sample 6, trench 6, zone 3
40. Hair cell phytolith, sample 6, trench 6, zone 3



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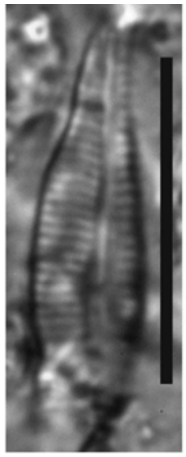

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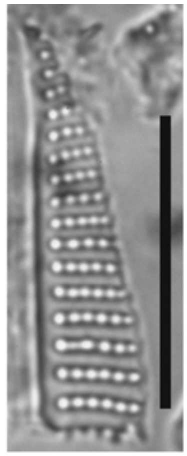

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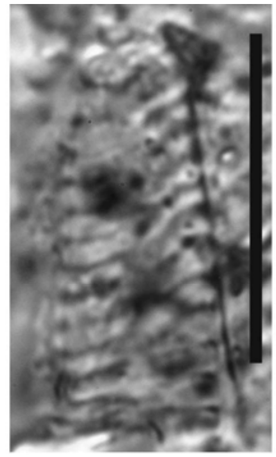

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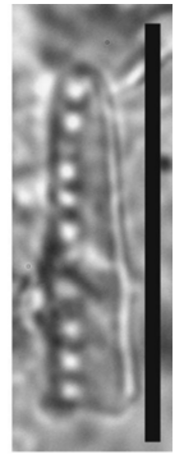

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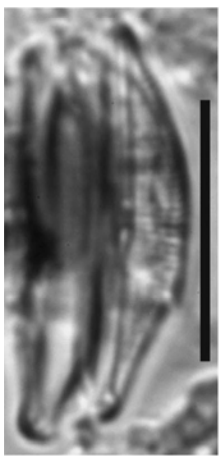

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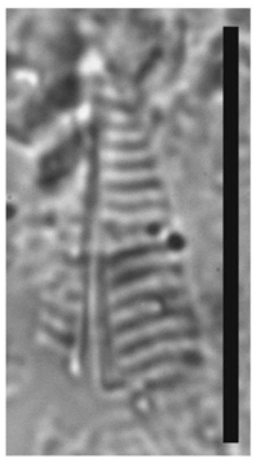

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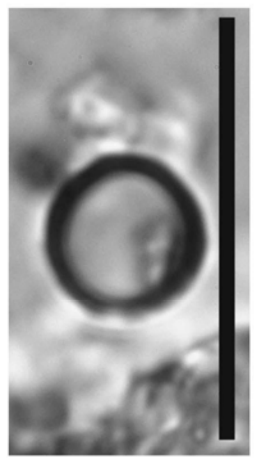

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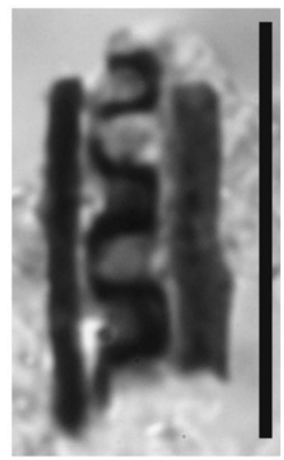

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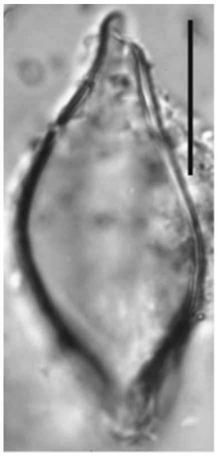
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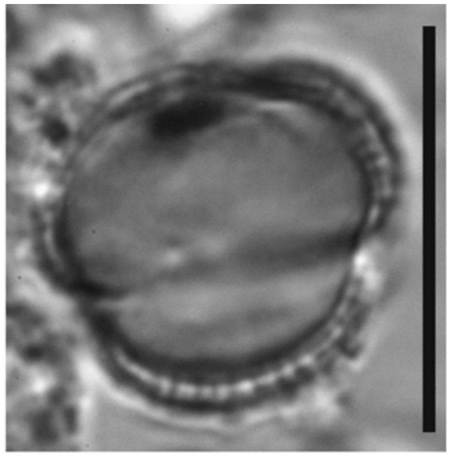
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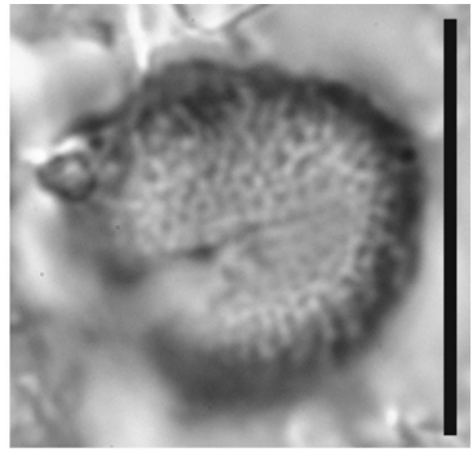
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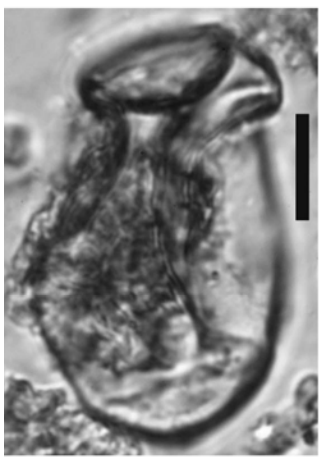
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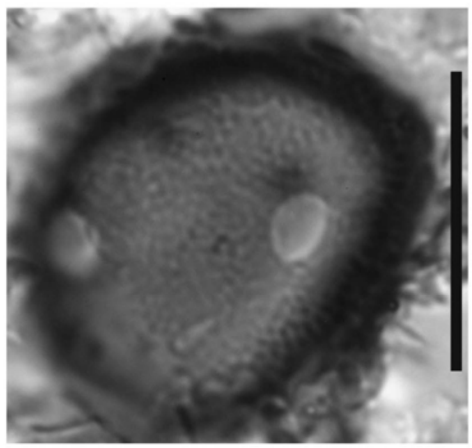
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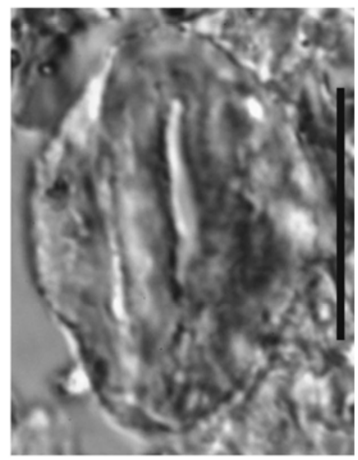
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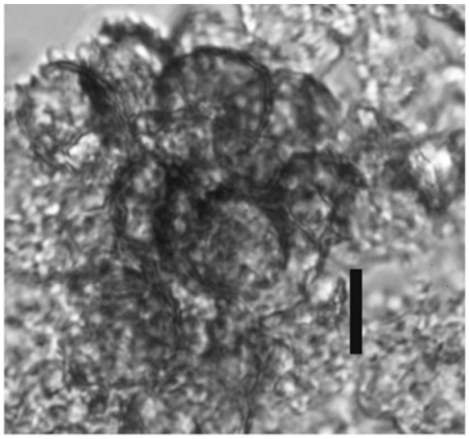

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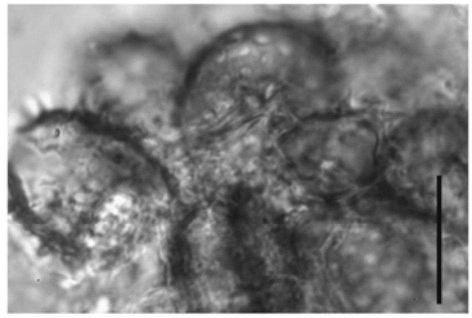

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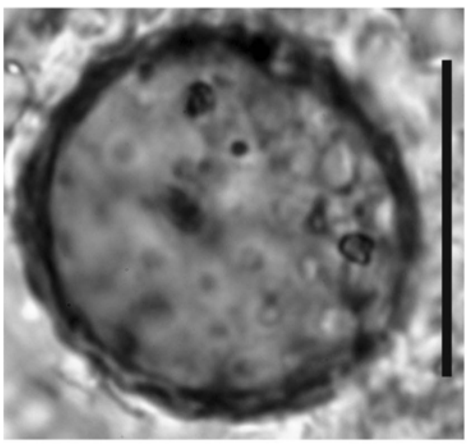

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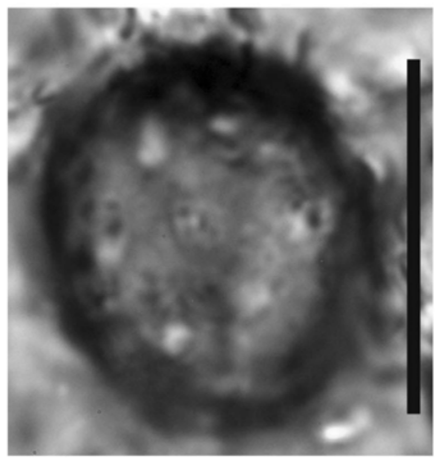

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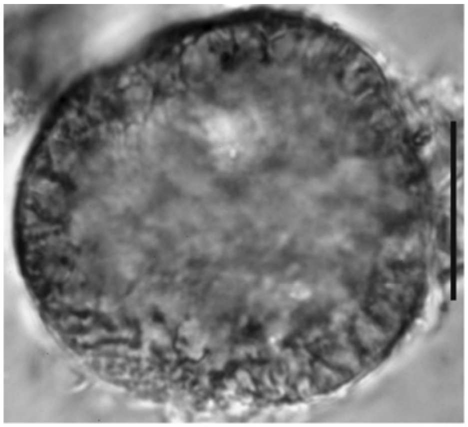

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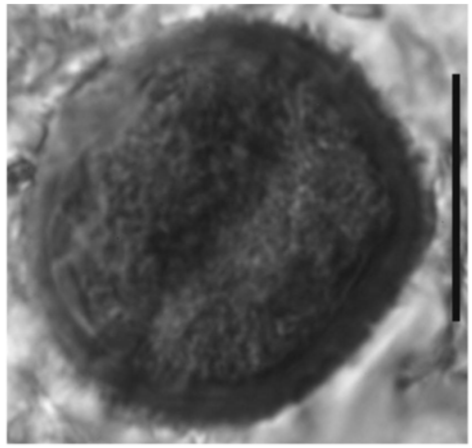

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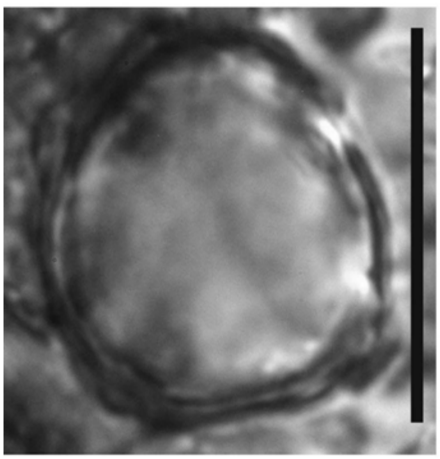

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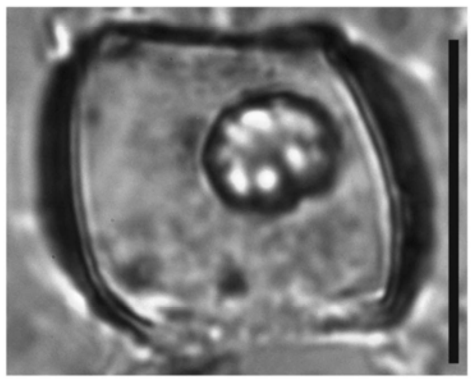

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Appendix D: Stable Isotope Analysis

Sample	Date	Position	Mass (mg)	CO2 Ampl (volts)	N2 Ampl (volts)	CO2 Area (V/s)	N2 Area (V/s)	$\delta^{13}C$ (‰)	$\delta^{15}N$ (‰)	%C	%N	C/N	Comments
No treatment													
LP1-1	22-Nov-10	17	74.163	2.05	0.30	42.70	6.31	-10.29	5.41	0.41	0.02	25.57	
LP1-2A	22-Nov-10	18	74.104	2.32	0.39	48.16	8.22	-10.03	4.69	0.46	0.02	22.13	
LP1-2AB	22-Nov-10	20	75.167	6.09	0.78	134.22	15.24	-7.71	5.21	1.26	0.04	33.27	
LP1-2B	22-Nov-10	19	74.722	3.19	0.38	66.99	7.73	-8.61	5.72	0.63	0.02	32.73	
LP1-3	22-Nov-10	21	75.291	3.78	0.49	81.03	9.89	-7.71	6.41	0.76	0.02	30.94	
LP1-4	22-Nov-10	22	75.510	1.58	0.17	32.71	3.67	-8.37	6.51	0.31	0.01	33.65	
LP1-5	22-Nov-10	23	75.594	2.65	0.24	56.14	4.99	-6.67	7.31	0.52	0.01	42.46	
LP1-6	22-Nov-10	24	74.140	2.17	0.12	46.11	2.73	-6.50	7.55	0.44	0.01	63.86	
LP1-7	22-Nov-10	26	74.677	3.29	0.27	69.73	5.93	-7.25	7.03	0.66	0.01	44.38	
LP1-7	22-Nov-10	27	74.307	3.55	0.27	75.37	5.85	-6.90	7.40	0.72	0.01	48.62	
LP1-8	22-Nov-10	28	74.652	2.84	0.23	59.61	5.02	-7.12	6.54	0.56	0.01	44.85	
LP1-9	22-Nov-10	29	75.530	2.32	0.11	48.76	2.48	-6.33	6.78	0.46	0.01	74.33	
LP1-10	22-Nov-10	30	75.497	3.95	0.31	83.68	6.63	-7.61	7.10	0.78	0.02	47.63	
LP1-11	22-Nov-10	31	75.503	3.95	0.30	83.58	6.35	-7.52	7.01	0.78	0.02	49.68	
LP1-12	22-Nov-10	32	75.045	2.59	0.13	54.62	2.90	-6.69	5.67	0.51	0.01	71.08	
LP1-13	22-Nov-10	33	75.547	2.66	0.12	56.01	2.79	-6.77	5.38	0.52	0.01	75.86	
LP1-14	22-Nov-10	34	75.278	1.36	0.12	27.87	2.72	-11.40	6.10	0.26	0.01	38.63	
LP3-1	22-Nov-10	4	74.971	3.76	0.49	83.17	10.48	-10.21	5.18	0.78	0.03	29.97	
LP3-1	22-Nov-10	5	75.454	3.82	0.49	84.42	10.56	-10.03	5.34	0.79	0.03	30.19	
LP4-3	22-Nov-10	10	74.539	4.28	1.15	93.87	24.27	-17.85	8.22	0.89	0.06	14.61	
LP4-4	22-Nov-10	11	75.435	3.05	0.52	64.83	11.01	-9.53	9.60	0.61	0.03	22.24	
LP4-5	22-Nov-10	12	75.906	3.25	0.37	69.38	7.68	-7.55	8.86	0.64	0.02	34.11	
LP4-8	22-Nov-10	14	75.176	7.17	0.19	163.85	3.79	-4.92	8.36	1.54	0.01	163.08	
LP4-8	22-Nov-10	15	75.004	6.95	0.19	158.34	3.82	-4.93	8.19	1.49	0.01	156.53	
LP4-9	22-Nov-10	16	75.188	0.94	0.14	19.01	3.07	-12.29	7.61	0.18	0.01	23.39	
LP5-1	22-Nov-10	9	75.697	1.79	0.59	38.16	12.85	-20.35	7.86	0.36	0.03	11.22	
LP5-2	22-Nov-10	8	75.253	1.55	0.49	33.15	10.87	-19.86	8.30	0.31	0.03	11.51	
LP5-3	22-Nov-10	7	75.718	2.03	0.59	43.67	12.92	-19.06	8.21	0.41	0.03	12.77	
LP5-4	22-Nov-10	6	75.653	3.37	0.76	73.96	16.44	-14.13	8.94	0.69	0.04	16.99	
STRATUM I	22-Nov-10	35	74.351	3.33	0.91	71.63	19.43	-20.31	7.67	0.68	0.05	13.92	
STRATUM II	22-Nov-10	36	75.582	6.73	0.99	152.65	20.55	-11.90	10.31	1.42	0.05	28.06	
STRATUM III	22-Nov-10	38	74.785	4.52	0.66	98.31	13.98	-11.91	10.76	0.93	0.03	26.55	
STRATUM III	22-Nov-10	39	75.370	4.32	0.65	93.52	13.64	-11.89	10.71	0.87	0.03	25.89	
STRATUM IV	22-Nov-10	40	74.637	1.85	0.22	38.53	4.91	-9.13	9.40	0.36	0.01	29.66	
STRATUM V	22-Nov-10	41	74.946	0.77	0.17	15.47	3.79	-13.49	9.70	0.15	0.01	15.41	
			min	**0.77**	**0.11**	**15.47**	**2.48**	**-20.35**	**4.69**	**0.15**	**0.01**	**11.22**	
			max	**7.17**	**1.15**	**163.85**	**24.27**	**-4.92**	**10.76**	**1.54**	**0.06**	**163.08**	
HCl-treatment													
LP1-1	6-Dec-10	18	75.727	0.56	0.20	11.72	4.92	-19.97	4.43	0.11	0.01	9.14	
LP1-2A	6-Dec-10	32	74.268	1.19	0.48	25.52	11.04	-17.67	4.71	0.24	0.03	8.87	
LP1-2AB	6-Dec-10	11	74.135	1.68	0.70	37.66	15.26	-18.52	5.40	0.35	0.04	9.48	
LP1-2B	6-Dec-10	28	75.372	1.34	0.46	28.93	10.60	-20.86	7.53	0.26	0.03	10.48	
LP1-3	6-Dec-10	26	75.522	1.09	0.43	22.93	10.02	-17.22	6.24	0.21	0.02	8.79	
LP1-3	6-Dec-10	27	74.343	1.47	0.59	31.36	13.17	-17.03	6.39	0.29	0.03	9.14	
LP1-4	6-Dec-10	8	75.108	0.35	0.14	7.22	3.39	-19.10	5.85	0.07	0.01	8.17	
LP1-5	6-Dec-10	36	74.655	0.50	0.22	10.27	5.30	-18.43	5.45	0.09	0.01	7.45	
LP1-6	6-Dec-10	10	74.579	0.43	0.14	9.01	3.56	-21.20	6.29	0.08	0.01	9.73	
LP1-7	6-Dec-10	17	75.490	0.58	0.22	12.18	5.38	-18.00	6.45	0.11	0.01	8.69	
LP1-8	6-Dec-10	20	75.077	0.66	0.22	13.56	5.34	-19.25	5.43	0.12	0.01	9.75	
LP1-9	6-Dec-10	23	74.539	0.21	0.07	4.17	1.52	-21.27	5.46	0.04	0.00	10.56	
LP1-10	6-Dec-10	24	74.335	0.79	0.32	16.44	7.65	-18.85	7.26	0.15	0.02	8.25	
LP1-11	6-Dec-10	35	74.331	1.07	0.37	22.59	8.72	-19.71	7.08	0.21	0.02	9.94	
LP1-12	6-Dec-10	7	75.204	0.36	0.13	7.30	3.30	-22.10	6.16	0.07	0.01	8.48	

Sample	Date	Position	Mass	CO2 Ampl	N2 Ampl	CO2 Area	N2 Area	$\delta^{13}C$	$\delta^{15}N$	%C	%N	C/N	Comments
			(mg)	(volts)	(volts)	(V/s)	(V/s)	(‰)	(‰)				
LP1-13	6-Dec-10	4	74.386	0.30	0.13	6.13	3.19	-23.40	5.30	0.06	0.01	7.38	
LP1-13	6-Dec-10	5	75.147	0.25	0.12	5.14	2.91	-23.54	4.92	0.05	0.01	6.79	
LP1-14	6-Dec-10	38	75.528	0.32	0.08	6.33	1.89	-23.29	3.16	0.06	0.00	12.88	
LP1-14	6-Dec-10	39	74.739	0.30	0.07	6.09	1.77	-23.42	2.74	0.06	0.00	13.25	
LP3-1	6-Dec-10	9	75.853	1.19	0.48	26.66	11.08	-19.33	5.38	0.24	0.03	9.24	
LP4-3	6-Dec-10	19	75.490	3.08	0.96	67.06	21.54	-19.65	8.31	0.61	0.05	11.95	
LP4-4	6-Dec-10	40	75.378	1.22	0.44	26.32	10.27	-17.29	8.81	0.24	0.02	9.84	
LP4-5	6-Dec-10	14	74.427	0.83	0.31	17.94	7.34	-17.98	8.57	0.17	0.02	9.39	
LP4-5	6-Dec-10	15	74.959	0.87	0.33	18.78	7.78	-17.96	8.28	0.17	0.02	9.26	
LP4-8	6-Dec-10	6	74.897	0.69	0.25	14.63	5.74	-19.88	8.17	0.13	0.01	9.78	
LP4-9	6-Dec-10	41	74.785	0.37	0.09	7.50	1.90	-22.78	4.74	0.07	0.00	15.13	
LP5-1	6-Dec-10	30	74.790	0.59	0.20	12.06	4.17	-21.26	9.30	0.11	0.01	11.09	
LP5-2	6-Dec-10	12	74.774	1.46	0.49	32.53	11.17	-20.50	8.62	0.30	0.03	11.18	
LP5-3	6-Dec-10	34	75.817	1.58	0.52	34.62	11.97	-19.31	8.69	0.31	0.03	11.10	
LP5-4	6-Dec-10	22	74.406	1.71	0.56	38.00	13.05	-19.31	8.15	0.35	0.03	11.18	
STRATUM I	6-Dec-10	21	75.214	2.08	0.78	46.43	17.50	-22.93	8.21	0.42	0.04	10.19	
STRATUM II	6-Dec-10	16	75.453	2.74	0.79	62.23	17.69	-20.51	10.36	0.56	0.04	13.51	
STRATUM III	6-Dec-10	31	75.683	2.03	0.60	44.19	13.32	-19.36	10.81	0.40	0.03	12.74	
STRATUM IV	6-Dec-10	33	74.369	0.62	0.24	12.65	5.10	-18.47	9.19	0.12	0.01	9.52	
STRATUM V	6-Dec-10	29	75.413	0.83	0.30	17.28	7.14	-18.68	5.10	0.16	0.02	9.29	
			min	**0.21**	**0.07**	**4.17**	**1.52**	**-23.54**	**2.74**	**0.04**	**0.00**	**6.79**	
			max	**3.08**	**0.96**	**67.06**	**21.54**	**-17.03**	**10.81**	**0.61**	**0.05**	**15.13**	
Drift and linearity standards													
NIST peach leaves	22-Nov-10	3	2.020	6.02	1.39	139.99	30.28	-26.42	1.84	46.57	2.85	16.32	
NIST peach leaves	22-Nov-10	13	2.020	6.20	1.46	139.05	30.20	-26.08	1.87	46.10	2.84	16.21	
NIST peach leaves	22-Nov-10	25	1.973	6.03	1.41	136.50	29.78	-26.32	2.07	46.48	2.87	16.19	
NIST peach leaves	22-Nov-10	37	2.026	6.29	1.49	141.46	31.24	-26.10	2.12	46.73	2.93	15.96	
NIST peach leaves	22-Nov-10	42	5.989	15.77	4.91	464.30	95.22	-26.24	1.98	46.67	2.89	16.14	
NIST peach leaves	22-Nov-10	43	5.004	13.72	3.97	380.62	78.44	-26.09	1.82	46.48	2.89	16.08	
NIST peach leaves	22-Nov-10	44	3.997	11.45	3.11	297.65	62.42	-26.09	1.86	46.52	2.91	15.97	
NIST peach leaves	22-Nov-10	45	3.007	9.06	2.29	218.92	46.68	-26.02	1.74	46.81	2.92	16.01	
NIST peach leaves	22-Nov-10	46	2.011	6.26	1.47	140.71	30.86	-26.06	1.86	46.86	2.92	16.07	
NIST peach leaves	22-Nov-10	47	1.494	4.65	1.07	101.58	22.79	-26.09	1.95	46.78	2.91	16.08	
NIST peach leaves	22-Nov-10	48	1.000	3.07	0.70	65.63	15.20	-26.30	1.89	46.54	2.91	16.00	
NIST peach leaves	22-Nov-10	49	0.498	1.46	0.34	30.36	7.46	-26.19	2.02	46.75	2.88	16.24	
NIST peach leaves	22-Nov-10	50	0.248	0.71	0.16	14.34	3.77	-26.13	1.69	46.44	2.92	15.91	
NIST peach leaves	6-Dec-10	3	1.993	5.77	1.56	140.12	32.68	-26.26	2.13	46.17	3.01	15.33	
NIST peach leaves	6-Dec-10	13	2.034	5.89	1.56	142.70	32.63	-26.14	1.98	45.96	2.95	15.58	
NIST peach leaves	6-Dec-10	25	1.946	5.71	1.49	136.10	30.99	-26.01	2.05	45.98	2.94	15.64	
NIST peach leaves	6-Dec-10	37	1.984	5.73	1.55	138.84	31.78	-26.05	1.98	45.98	2.95	15.60	
NIST peach leaves	6-Dec-10	49	2.025	5.92	1.58	142.96	32.63	-26.00	1.92	46.23	2.96	15.62	
NIST peach leaves	6-Dec-10	61	2.007	5.86	1.56	141.68	32.36	-25.95	2.01	46.28	2.96	15.61	
NIST peach leaves	6-Dec-10	73	2.000	5.72	1.54	140.12	31.96	-26.01	2.04	46.04	2.94	15.65	
NIST peach leaves	6-Dec-10	85	2.049	6.08	1.59	145.41	32.76	-26.18	2.18	46.33	2.94	15.79	
NIST peach leaves	6-Dec-10	95	5.998	15.22	5.27	471.59	100.99	-26.08	2.01	46.34	2.80	16.55	
NIST peach leaves	6-Dec-10	96	4.993	13.19	4.27	387.00	83.20	-26.06	1.76	46.21	2.82	16.39	
NIST peach leaves	6-Dec-10	97	4.009	10.99	3.33	304.01	66.27	-26.02	1.55	46.09	2.85	16.14	
NIST peach leaves	6-Dec-10	98	3.003	8.58	2.43	220.56	48.69	-26.02	1.66	45.99	2.87	16.00	
NIST peach leaves	6-Dec-10	99	2.005	6.01	1.57	143.10	32.04	-26.01	2.01	46.68	2.94	15.89	
NIST peach leaves	6-Dec-10	100	1.504	4.54	1.14	104.40	23.39	-26.06	1.99	46.76	2.94	15.91	
NIST peach leaves	6-Dec-10	101	1.000	3.04	0.73	67.07	14.78	-26.07	1.93	46.27	2.91	15.90	
NIST peach leaves	6-Dec-10	102	0.504	1.48	0.33	31.64	6.86	-26.03	1.93	45.89	2.89	15.88	
NIST peach leaves	6-Dec-10	103	0.246	0.67	0.15	13.64	3.07	-26.14	1.65	46.95	2.88	16.31	

Sample	Date	Position	Mass	CO2 Ampl	N2 Ampl	CO2 Area	N2 Area	$\delta^{13}C$	$\delta^{15}N$	%C	%N	C/N	Comments
			(mg)	(volts)	(volts)	(V/s)	(V/s)	(‰)	(‰)				
NIST peach leaves	6-Dec-10	104	0.129	0.32	0.07	6.25	1.46	-26.01	1.60	45.78	2.85	16.06	
			min	**0.32**	**0.07**		**avg**	**-26.10**	**1.91**	**46.38**	**2.90**	**15.97**	
			max	**15.77**	**5.27**		**sd**	**0.11**	**0.16**	**0.33**	**0.05**	**0.27**	
Isotope calibration standards													**Expected**
IAEA CH6	22-Nov-10	52	1.225	3.38		72.79		-10.52		42.43			**d13C = -10.45**
IAEA CH6	6-Dec-10	105	1.205	3.28		73.19		-10.45		42.14			**d13C = -10.45**
IAEA CH7	22-Nov-10	53	0.758	4.31		93.66		-32.14		86.86			**d13C = -32.15**
IAEA CH7	6-Dec-10	106	0.731	4.05		91.73		-32.15		85.87			**d13C = -32.15**
IAEA N1	22-Nov-10	54	0.291		1.48		32.84		0.56		20.71		**d15N = 0.43**
IAEA N1	6-Dec-10	107	0.294		1.64		33.48		0.67		20.17		**d15N = 0.43**
IAEA N2	22-Nov-10	55	0.296		1.52		33.67		20.31		20.87		**d15N = 20.41**
IAEA N2	6-Dec-10	108	0.305		1.74		35.61		20.43		20.67		**d15N = 20.41**
Elemental calibration standards													
Acetanilide	22-Nov-10	56	0.786	3.63	2.05	78.84	44.06	-33.88	-0.85	71.13	10.33	6.89	**C/N = 71.09/10.36 = 6.86**
Acetanilide	6-Dec-10	109	0.796	3.71	2.34	82.59	46.81	-33.87	-0.91	71.28	10.39	6.86	**C/N = 71.09/10.36 = 6.86**
BBOT	22-Nov-10	57	0.809	3.85	1.31	83.75	28.28	-26.57	-10.76	73.16	6.50	11.26	**C/N = 72.53/6.51 = 11.14**
BBOT	6-Dec-10	110	0.793	3.73	1.39	83.62	28.06	-26.52	-10.75	72.42	6.38	11.34	**C/N = 72.53/6.51 = 11.14**
Cyclohexanone	22-Nov-10	61	0.611	1.98	3.05	42.28	67.05	-27.01	-3.64	51.08	20.09	2.54	C/N = 51.79/20.14 = 2.57
Cyclohexanone	6-Dec-10	114	0.621	2.04	3.49	44.19	71.35	-26.97	-3.79	50.77	20.17	2.52	C/N = 51.79/20.14 = 2.57
Cystine	22-Nov-10	58	0.985	1.86	2.85	39.20	62.14	-16.52	8.69	30.40	11.59	2.62	**C/N = 29.95/11.61 = 2.57**
Cystine	6-Dec-10	111	0.972	1.85	3.14	39.73	64.19	-16.46	8.30	30.16	11.59	2.60	**C/N = 29.95/11.61 = 2.57**
Methionine	22-Nov-10	59	0.998	2.58	2.35	55.09	50.87	-25.19	-0.97	40.40	9.39	4.30	**C/N = 40.21/9.39 = 4.28**
Methionine	6-Dec-10	112	1.008	2.62	2.65	57.16	53.67	-25.12	-1.11	40.12	9.38	4.28	**C/N = 40.21/9.39 = 4.28**
Nicotinamide	22-Nov-10	62	0.628	2.36	3.65	50.41	79.16	-33.00	-1.50	58.47	23.05	2.54	**C/N = 59.01/22.94 = 2.57**
Nicotinamide	6-Dec-10	115	0.618	2.34	4.01	50.82	81.44	-32.96	-1.54	58.03	23.11	2.51	**C/N = 59.01/22.94 = 2.57**
Sulfanilamide	22-Nov-10	60	0.747	1.98	3.04	41.89	66.08	-28.98	-1.68	41.78	16.21	2.58	**C/N = 41.84/16.27 = 2.57**
Sulfanilamide	6-Dec-10	113	0.756	2.03	3.45	43.75	70.32	-28.84	-1.56	41.64	16.32	2.55	**C/N = 41.84/16.27 = 2.57**
Secondary check standards													
Caffeine - Aldrich	22-Nov-10	68	0.479	1.46	3.44	30.77	75.61	-39.08	-3.47	48.26	28.86	1.67	
Caffeine - Aldrich	6-Dec-10	121	0.525	1.65	4.31	35.31	87.61	-39.15	-3.38	48.56	29.28	1.66	
NIST apple leaves	22-Nov-10	64	2.968	9.07	1.71	220.16	34.95	-26.90	0.34	47.50	2.26	21.05	
NIST apple leaves	6-Dec-10	117	2.962	8.52	1.82	223.29	36.62	-26.94	0.20	47.36	2.26	20.92	
NIST bovine liver	22-Nov-10	66	0.991	3.20	2.55	69.03	54.90	-21.65	7.75	49.89	10.19	4.89	
NIST bovine liver	6-Dec-10	119	1.045	3.32	2.97	74.97	60.93	-21.63	7.57	49.67	10.24	4.85	
NIST mussel tissue	22-Nov-10	67	0.989	2.47	1.90	52.69	41.06	-18.42	7.68	39.18	7.68	5.10	
NIST mussel tissue	6-Dec-10	120	1.007	2.58	2.20	56.97	45.35	-18.56	7.41	40.08	7.97	5.03	
NIST pine needles	22-Nov-10	63	4.967	14.27	1.53	403.76	29.70	-26.11	0.55	49.93	1.20	41.45	
NIST pine needles	6-Dec-10	116	4.989	13.75	1.68	413.54	31.70	-26.13	0.75	49.71	1.23	40.55	
NIST tomato leaves	22-Nov-10	65	2.943	7.16	2.30	164.24	47.58	-27.06	3.88	36.00	3.04	11.84	
NIST tomato leaves	6-Dec-10	118	3.027	7.01	2.53	173.25	51.62	-27.05	4.07	36.06	3.01	11.97	
Soil standards													
B2150	22-Nov-10	69	11.992	4.93	1.39	108.78	29.17	-19.93	5.02	6.40	0.45	14.08	**C/N = 6.40/0.45 = 14.15**
B2150	6-Dec-10	122	11.875	4.72	1.46	110.47	30.10	-20.03	5.00	6.37	0.45	14.09	**C/N = 6.40/0.45 = 14.15**
B2152	22-Nov-10	72	59.342	4.90	1.56	108.21	32.80	-26.85	7.10	1.29	0.10	12.46	**C/N = 1.27/0.10 = 12.27**
B2152	6-Dec-10	125	60.618	4.80	1.68	113.92	35.73	-26.86	6.86	1.29	0.11	12.24	**C/N = 1.27/0.10 = 12.27**
NIST 2710	22-Nov-10	70	20.036	3.98	1.47	87.15	31.51	-24.88	5.17	3.07	0.29	10.44	**C/N = 3.10/0.29 = 10.57**
NIST 2710	6-Dec-10	123	19.792	3.91	1.55	89.38	32.35	-25.00	5.16	3.09	0.29	10.61	**C/N = 3.10/0.29 = 10.57**
NIST 2711	22-Nov-10	71	39.990	4.66	1.36	100.77	28.49	-17.12	7.53	1.78	0.13	13.36	**C/N = 1.77/0.13 = 13.31**
NIST 2711	6-Dec-10	124	39.924	4.45	1.39	103.02	29.59	-17.08	7.68	1.77	0.13	13.37	**C/N = 1.77/0.13 = 13.31**
			min	**0.21**	**0.07**	**4.17**	**1.46**	**-39.15**	**-10.76**	**0.04**	**0.00**	**0.27**	
			max	**15.77**	**5.27**	**471.59**	**100.99**	**0.11**	**20.43**	**86.86**	**29.28**	**41.45**	

Appendix E: Starch Grain Analysis

Starch Analysis of Lea County Site LA 5148

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Introduction to Starch Grain Analyses

Archaeobotanical investigators are constantly seeking new methods by which previously unobtainable data can be recovered. Among archaeologists who work in regions characterized by the poor preservation of organic remains, the analyses of starch granules have proven particularly useful in accessing the residues of starchy root and tuber crops that have previously been invisible in the archaeological record (Bryant 2003; Coil et al. 2003; Fullagar et al. 1998; Hall et al. 1989; Iriarté et al. 2004; Loy et al. 1992; Pearsall et al. 2004; Perry 2001, 2002a, 2004, 2005, 2007; Perry et al. 2006, 2007; Piperno and Holst 1998; Piperno et al. 2000). These residues have proven to be tenacious survivors in harsh climates, and their preservation on the surfaces of lithic tools that were used in the processing of starch-bearing plants occurs consistently in archaeobotanical investigations (Iriarté et al. 2004; Pearsall et al. 2004; Perry 2001, 2002a, 2004, 2005, 2007; Perry et al. 2006, 2007; Piperno and Holst 1998; Piperno et al. 2000).

Investigations of the starchy remains of plant foods on the surfaces of archaeological lithic tools began with simple analyses using chemical reagents that identified the residues in question as plant-derived storage starch (Bruier 1976) rather than animal tissue. Within the last fifteen years, however, archaeologists have been successfully employing morphological criteria to identify plant taxa. The methods are almost identical to those used in the analysis of phytolith microfossils.

Just as different plants produce characteristically shaped leaves, flowers, and seeds, different genera and species make starch grains that are distinctive to and diagnostic for each taxon. The anatomical features that distinguish the starch of one species of plant from another have been noted by botanists (e.g., Denniston 1904; MacMasters 1964; Reichert 1913), and their methods have been expanded by archaeobotanists who are now able even to distinguish wild from domesticated species in some plant families (Iriarté et al. 2004; Pearsall et al. 2004; Perry 2001, 2002a, 2004; Piperno et al. 2000). Basic physical features that are comparable between modern reference specimens and archaeological samples can be viewed using a light microscope and include gross morphological features such as shape and faceting, the location of and appearance of the hilum, and presence and patterning of lamellae (Iriarté et al. 2004; Loy 1994; Pearsall 2004; Perry 2004; Piperno and Holst 1998; Piperno et al. 2000). Fissuring and other internal patterning have also proven to be useful criteria for identification. The successful identification of starch granules relies upon the viewing of each granule in three dimensions to gain an accurate assessment of its morphological features.

Because starch granules differ morphologically between plants, their distinctive characteristics can often allow identification to the level of genus or species in archaeological samples (e.g., Iriarté et al. 2004; Pearsall et al. 2004; Perry 2001, 2002a, 2004, 2005, 2006, 2007a, 2007b; Piperno and Holst 1998; Piperno et al. 2000). The method has proven particularly useful in identifying the remains of plant tissues that would not usually be preserved as macroremains, such as the remnants of root and tuber crops (Bryant 2003; Coil et al. 2003; Fullagar et al. 1998; Hall et al. 1989; Iriarté et al. 2004; Loy et al. 1992; Pearsall et al. 2004; Perry 2001, 2002a, 2004, 2005; Piperno and Holst 1998; Piperno et al. 2000). This role of starch analysis as a tool for revealing the significance of plant foods in the archaeobotanical record also adds to our understanding of the pre-contact significance of starchy seed crops like maize (*Zea mays*).

In a citation of preliminary results from an ongoing study, the archaeological remains of maize starch have been extracted from 2000 year-old obsidian artifacts from the Honduran site of Copán (Haslam 2003, 2004). The starchy residues of maize were also successfully recovered and identified from a migmatite milling stone from Cueva de los Corrales 1 in Argentina (Babot and Apella 2003). In this case, the grinding stone was found to have multiple purposes, including the grinding of burnt bone, presumable for a non-food purpose. Starch analyses of groundstone artifacts from Real Alto have supported previously published phytolith studies that indicate the great antiquity of maize in Ecuador, and its role in subsistence during the Formative period (Pearsall et al. 2004). Seventeen examined artifacts from Real Alto yielded concentrations of maize starch granules ranging from one to more than ten granules per sampled tool. Other Neotropical studies have resulted in the recovery of more complex assemblages of starches.

Archaeologists have recovered starch granules from maize, beans (*Phaseolus* sp.), and *Canna* from the Los Ajos mound complex in Uruguay (Iriarté et al. 2004). Maize starch granules were reported from three groundstone tools including one mano and two milling stone bases. Concentrations of maize starches ranged from two to eleven granules on tools from contexts dating from 3600 years before present to about 500 years before present (Iriarté et al. 2004: supplementary information). The starch data were combined with phytolith evidence and, together, these results introduce compelling evidence for the early development of a mixed subsistence economy in this region of South America. In other regions of the Neotropics, starch analysis has been an essential tool in defining similar subsistence patterns that included the exploitation of root and tuberous food plants.

Starch granules of maize, manioc (*Manihot esculenta*), both wild type and domesticated yams (*Dioscorea* spp.), and arrowroot (*Maranta arundinacea*) have been recovered from edge ground cobbles and grinding stone bases collected from the Aguadulce rock shelter as well as the sites of Monagrillo, La Mula, and Cerro Juan Diaz in Panama (Piperno and Holst 1998; Piperno et al. 2000). Edge ground cobbles are characterized by faceting that is hypothesized to have resulted from the processing of root crops against larger grinding stone bases (Ranere 1975), and the analyses of the residual remains of plant tissues supports this hypothesis. However, the use of the milling stones does appear to have been more complex than previously believed. Maize remains were recovered from all twelve artifacts that bore starch (Piperno et al. 2000). The numbers of starch granules of maize per artifact ranged from one to twenty-five per artifact. Two starch granules of arrowroot occurred on a single artifact, manioc starch granules were recovered from three artifacts (one, five, and eight granules), and yam starch granules were found on the surfaces of three of the artifacts (two, three, and sixteen granules) (Piperno et al. 2000). These investigations resulted in the recovery of the oldest evidence for root and tuber crop cultivation in the Neotropics, with radiocarbon dates spanning from 5,000 to 7,000 years before present.

Starch granules of maize, yams, and arrowroot have also been recovered from twelve flake and three groundstone tools collected from Pozo Azul Norte 1 and Los Mangos del Parguaza in Venezuela (Perry 2001, 2002a, 2004, 2005). These sites date from the middle first century AD to contact. As in the above-cited set of studies, maize remains were recovered from every examined artifact and ranged in number from two to fifty-one per artifact. Additionally, four granules of yam starch were recovered from two flake tools, four flake tools yielded four granules of guapo (*Myrosma* sp.) starch, and seven starch granules from arrowroot were collected from five tools, one of which was a groundstone artifact. These findings were significant in that five of the examined artifacts were chosen for study due to their hypothetical function as microlithic grater flakes from a manioc specific grater board. The evidence indicated a more complex function of these tools that did not include the processing of manioc.

More recent investigations have led to the recovery of direct evidence for contact between the highland Peruvian Andes and the lowland tropical forest to the east (Perry et al. 2006). This contact and interaction had been a significant component of Andean theory for decades, but direct evidence had been elusive until starch microfossils of arrowroot were collected from both sediment samples and lithic tools at the mid-elevation site of Waynuna (Perry et al. 2006). Further, the discovery and cataloging of a microfossil will allow for the recovery and understanding of the origins and subsequent dispersals of chili peppers (Perry et al. 2007), plants whose histories are poorly understood due to the lack of preservation of macroremains in the archaeobotanical record. Remains of these plants have been successfully recovered throughout the Americas from ceramic sherds, lithic tools, and sediment samples dating from 6250 BP to European contact.

Understanding the relationship between residues and artifacts

Early work on starch remains from Panamanian sites used stepwise analysis to support the direct association between starchy residues on tools and the tools' use (Piperno et al. 2000). These studies demonstrated that starch grains were not present in sediments adhering to stone tools or on unused parts of the lithics, but they did occur in the cracks and crevices of the tools on used surfaces, thus indicating that the residues were the result of the tools' use and not environmental contamination. Similar experiments have been undertaken independently by other researchers, and the results were equivalent.

In a study of obsidian artifacts recovered from an open air site in Papua New Guinea, the frequency of starch granules recovered from stone artifacts was compared to that present in the soil matrix immediate to the tool (Barton et al. 1998). The frequency of starch granules was found to be much higher on used artifacts than in the surrounding soil. Thus, the conclusion was drawn that the tools were not contaminated by environmental starch sources. Further, use-wear analyses were used in combination with the soil and starch analyses to assess the degree of association of starchy residues with the used surfaces of tools (Barton et al. 1998). The researchers found that, indeed, the occurrence of starch granules was highly correlated with obsidian tools that bore use-wear and was not correlated with unused tools.

In a study of starch residues occurring on stone pounding tools from the Jimmium site in north central Australia, the starch forms in soil samples were compared to those extracted from the artifacts (Atchison and Fullagar 1998). It was found that, although starch granules did occur in the soil matrices surrounding the tools, they were of different size and shape than those present on the pounding stones, and, therefore, are probably not from the same plant source. This result was interpreted as evidence that the tools had not been contaminated by soil-borne starches.

Another method for assessing whether or not starch residues are culturally deposited involves the analysis of control samples from non-cultural contexts surrounding a site. If different types of starches, or different concentrations of starches, or no plant residue whatsoever are recovered from the control samples than are recovered from the artifacts undergoing testing, then one can be more secure that the residues are the remains of prehistoric food processing (Brieur 1976).

In addition to the study of association of microfossils with tool use, experimentation with processing methods has also been undertaken. In Argentina, a researcher replicated ancient Andean methods of food processing and found that each different process resulted in diagnostic damage to starch granules in plant tissues including potato tubers (*Solanum tuberosum*) and quinoa seeds (*Chenopodium* spp.) (Babot 2003). Modern plant materials were subjected to freeze-drying, dehydration, roasting, charring, desaponification (a process particular to the preparation of quinoa), and grinding. It was found that fragments of starches that would probably otherwise be identified as unknowns or non-starches are actually damaged starches. Further, with careful analysis, researchers can link damage patterns with processing techniques (Babot 2003). Experimentation with various cooking techniques have resulted in similar conclusions: cooked starches are identifiable as such, and different cooking techniques yield different patterns of damage (Henry et al. 2009).

Archaeobotanists have focused their energies upon honing their methods toward the effective recovery of and identification of residual starch granules to understand plant use and processing. Studies have resulted in an impressive assemblage of various suites of starchy food plants, both wild and domesticated, raw and cooked. At this juncture in time, more studies are being undertaken and starch remains are being successfully recovered. What we now lack are baseline data as to how and why different plant materials may or may not adhere to stone tools. Thus, we are not yet able to understand issues such as intensity of use based upon numbers of recovered grains, or the history of a tool based upon the numbers of species of plants recovered from its surface. Linda Perry has obtained funding and will be performing experiments over the next year in the hopes of gaining an understanding of these issues.

Methods

The methods of starch grain analysis can be distilled down into a few simple tasks. These tasks include removing the archaeological material from the artifact, placing it on a glass slide, and observing the residue using a light microscope. The analysis amounts to a careful cleaning of each artifact and examination of the material that was collected during cleaning. If the cleaning results in a relatively large quantity of sediment, the microfossils must be separated from the matrix so that they can be clearly viewed via microscopy. This step is completed with a heavy liquid flotation. Detailed methods are as follows.

Seven artifacts were chosen for analysis. Included in the sample were three groundstone tools and four ceramic sherds. All artifacts were collected and bagged separately without washing. Washing is a traditional step in the collection and curation of artifacts, but it will remove some of the residues that are of interest to archaeologists.

The artifacts were sampled using a clean, sonic toothbrush that was applied to the used surfaces of the groundstone artifacts and to the inside surfaces of the ceramic sherds. The wash water was then collected in vessels.

The effluent from the cleaning was allowed to settle overnight, then the settled material was centrifuged for ten minutes at 1000 RPM to pellet out the solids. The solid materials were then subject to a heavy liquid flotation using Cesium chloride (CsCl) at a density of 1.8 g/cm^3 to separate the starch grains from the sediment matrix.

The material collected from the flotation was rinsed and centrifuged three times with reverse-osmosis filtered water to ensure that the CsCl was completely removed from the solution. At this point, the pellet from the final centrifugation was placed on a clean glass slide with a small amount of water/glycerin solution. Slides were scanned with a Zeiss Universal compound microscope for polarized light at 200x, and identifications were made at 400x using standard methods. Digital images were captured at 800x magnification using a Micropublisher 3.3 camera and software.

Results and Discussion

All sampled artifacts yielded starch remains, both intact and damaged (Figure 1). A total of 42 starch grains were recovered, one of which remains unidentified. Of the identified starches, five are from maize (*Zea mays*), and the remaining 36 are derived from grasses in the Triticeae.

Starches in the category Lenticular Type 1 have characteristics consistent with those of members of the genus *Elymus*, or wildrye. Starches classified as Lenticular Type 2 bear morphological traits consistent with those of little barley (*Hordeum pusillum*). At this time, due to both the complexity of the assemblage and the relatively small number of sampled artifacts, the identifications will remain tentative. It is clear, however, that there are at least two types of grasses being used as food in addition to maize, and both of these types of grain were being processed into flour or meal and cooked in ceramic vessels on site.

Table 1: Starch remains recovered from samples from Site LA 5148.

Sample #	**Provenience**	**Artifact Type**	**Zea mays**	**Lenticular Type 1**	**Lenticular Type 2**	**Unidentified**	**Damaged**
6	TU2 F3	Groundstone		2			Grinding
47	Surface	Groundstone			6		Grinding
50	Surface	Groundstone			2		Heating
221	12S 2E-Z	Ceramic			2		Heating
229	N/A	Ceramic	2	1			Heating
517	6S 3W-A	Ceramic		9			Heating
662	B2	Ceramic	3	14		1	Heat/Grind
Totals		**7**	**5**	**26**	**10**	**1**	**42**

Groundstone Artifacts

Three groundstone artifacts were sampled, and all yielded both intact and damaged starch remains of Lenticular Types 1 and 2. The damaged starches provide solid evidence that these tools were used to grind grain.

Groundstone #6: This groundstone fragment yielded two intact starch grains that are consistent with Lenticular Type 1. Grinding damage was observed on one of the grains.

Groundstone #47: This mano yielded six intact starch grains of Lenticular Type 2, and also contained starch that was damage by grinding.

Groundstone #50: This mano yielded two starch grains consistent with Lenticular Type 2, and had a single grain that appears to have been damaged via heating. The presence of this grain on the stone could be an indicator of the processing of cooked foods with the stone.

Ceramic Sherds

Four ceramic sherds were sampled and all yielded starch remains of both lenticular forms, maize, and an unidentified plant. All sherds also yielded a matrix of debris that includes fragments of gelatinized starches as well as those that may indicate the parching of grain, but may also be due to the residues being "cooked" by heating above the level of liquid in the vessel. The presence of starch remains that have been exposed to heat is a solid indicator of the use of these vessels for the cooking of grain.

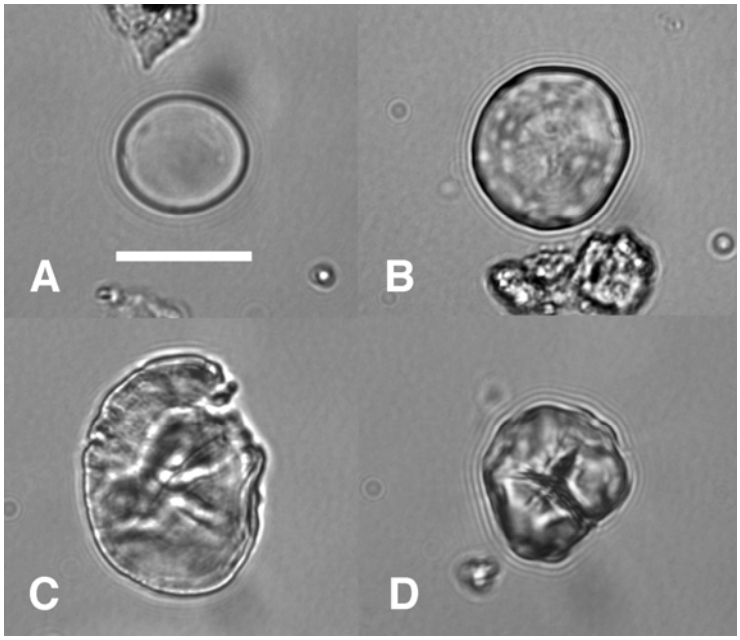
Ceramic sherd #221: Two starch grains classified in Lenticular Type 2 were recovered from this sherd. The remains of starches that have been damaged by exposure to heat, at least one of which was clearly heated in the presence of water, were also recovered.

Ceramic sherd #229: Two maize starch grains and a single starch from Lenticular Type 1 were recovered from this sherd. As is the case with the previous sherd, starch remains that have been exposed to heat were also recovered.

Ceramic sherd #517: This sherd yielded nine starch grains from Lenticular Type 1.   Evidence of heating was also present.

Ceramic sherd #662: Three starch grains from maize and 14 from Lenticular Type 1 were recovered from this sherd, as was a single, unidentified grain. Starch remains that have been damaged by heating and grinding were also present.

Figure 1: Starch remains. The scale bar indicates 20 microns. All images are at identical magnification. A. Lenticular Type 1 from Groundstone Artifact #6. B. Lenticular Type 2 from Groundstone #47. C. Lenticular starch with grinding damage from groundstone tool #47. D. Maize starch from Ceramic Sherd #662.



Conclusions

The starch remains provide solid evidence that the groundstone tools were used for grinding grain, and the ceramic vessels were cooking implements. Maize was in use at the site as were two different grasses that are probably wildrye and possibly little barley.

The overall patterning of the preliminary starch analyses indicates what may be an interesting story of local production and gathering as well as trade at the site. There are three “categories” of remains: the sole occurrence of Lenticular Type 1 on two artifacts, the combination of Lenticular Type 1 and maize on two artifacts, and Lenticular Type 2 alone on three artifacts. Maize does not occur on any of the grinding implements, but is present in cooking vessels, while both lenticular starches occur on each type of tool. It is also interesting that maize only occurs in the presence of Lenticular Type 1, and not Type 2. I have no solid explanation for why the remains fall out in this pattern. It appears that there may be at least two and possibly three different and distinct categories of foodstuffs, one or more of which may be part of a distinct temporal and/or spatial context.

With such a small sample size, it is difficult to interpret what these patterns indicate in terms of which plants may have been collected from wild stands around the site, which may have been obtained through trade, and which may have been cultivated on site. An absence of maize on the groundstone implements could indicate its introduction into the site through trade, however, with only three manos tested, no concrete conclusions can be drawn. Future research should include a wider sampling of artifacts from different spatial and temporal contexts so that a clearer understanding of the distributions of the different grains can be gained.

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Appendix F: FTIR Residue Analysis

ORGANIC RESIDUE (FTIR) ANALYSIS OF SAMPLES FROM SITE LA5148, LEA COUNTY, NEW MEXICO

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INTRODUCTION

Site LA 5148, located in the Laguna Plata Archaeological District of Lea County, New Mexico, was examined. The site was situated next to a playa. Groundstone, lithic tools, and ceramics recovered either in subsurface or from the modern surface were submitted for organic residue analysis using Fourier Transform Infrared Spectroscopy (FTIR). Analysis of organic residues will be used to gain information on paleodiet, specifically foods cooked in ceramic vessels, and materials ground and processed with groundstone and lithic tools.

METHODS

FTIR (Fourier Transform Infrared Spectroscopy)

A mixture of chloroform and methanol was used as a solvent to remove lipids and other organic substances that had soaked into the surface of the ceramic and stone. This mixture is represented in the FTIR graphics as CHM. The CHM solvent and sample were placed in a glass container, and allowed to sit, covered, for several hours. After this period of time, the solvent was pipetted into an aluminum evaporation dish, where the CHM was allowed to evaporate. This process leaves the residue of any absorbed chemicals in the aluminum dishes. The residue remaining in the aluminum dishes was then placed on the FTIR crystal and the spectra were collected. The aluminum dishes were tilted during the process of evaporation to separate the lighter from the heavier fraction of the residue. The lighter and heavier fractions are designated upper (lighter fraction) and lower (heavier fraction) respectively in the subsequent analysis.

FTIR is performed using a Nicolet 6700 optical bench with an ATR and a diamond crystal. The sample is placed in the path of a specially encoded infrared beam, which passes through the sample and produces a signal called an “inferogram.” The inferogram contains information about the frequencies of infrared that are absorbed and the strength of the absorptions, which is determined by the sample’s chemical make-up. A computer reads the inferogram and uses Fourier transformation to decode the intensity information for each frequency (wave numbers) and presents a spectrum.

FTIR (FOURIER TRANSFORM INFRARED SPECTROSCOPY) REVIEW

Infrared spectroscopy (IR) is the study of how molecules absorb infrared radiation and ultimately convert it to heat, revealing how the infrared energy is absorbed, as well as the structure of specific organic molecules. Infrared spectroscopy has been experiencing a renaissance for identifying organic substances during the past few decades. It is currently considered one of the more powerful tools in organic and analytical chemistry. One of the primary advantages to the FTIR is that it measures all wave lengths simultaneously. It has a relatively high signal-to-noise ratio and a short measurement time. Each peak in the spectrum represents either a chemical bond or a functional group.

Since molecular structures absorb the vibrational frequencies or wavelengths of infrared radiation, the bands of absorbance can then be used to identify the composition of the materials under study. In the case of the current research, the portion of the electromagnetic spectrum between 4000-400 wave numbers is used for identifying organic materials. Carbohydrates, lipids, proteins, and other organic molecules are associated with specific wave number bands (Isaksson 1999:36-39).

The infrared spectrum can be divided into two regions--the functional group region and the fingerprint region. These two groups are recognized by the effect that infrared radiation has on the respective molecules of these groups. The functional group region is located between 4000 and approximately 1500 wave numbers. The molecular bonds display specific characteristic vibrations that identify fats, lipids, waxes, lignins, proteins, carbohydrates, etc. The fingerprint region, located below 1500 wave numbers, is influenced by bending motions, which further identify the molecules present.

Using the FTIR, it is possible to identify different types of organic compounds and eventually recognize different types of materials such as plant or animal fats or lipids, plant waxes, esters, proteins, carbohydrates, and more. Specific regions of the spectrum are important in identifying these compounds.

The results of the identification of specific wavelengths can be compared with commercial or laboratory-created analytical standards to identify the specific types of bonds present in different materials. By combining the results of the analysis of individual samples with all of the reference materials in the PaleoResearch Institute (PRI) library, the percent match with individual reference items can be displayed. For instance, plant lipids or fats are identifiable between 3000-2800 wave numbers. A match might be obtained on this portion of the spectrum with nuts such as hickory, walnut, or acorn, or with animal fats or corn oil. Recovery of high level matches with several types of nuts (in this example) indicates that nuts were processed. If the match with the PRI library is with meats, then the fats matched are more consistent with those produced by meat than plant parts, such as nuts.

Samples containing many compounds are more difficult to identify – and many archaeological samples are complex mixtures. Multi-purpose artifacts, such as groundstone, which could have been used to crush or grind a variety of foodstuffs, or ceramic cooking vessels, which are expected to have been used to cook many different foods, might present a mixture problem. Mixtures sometimes have many absorption bands that overlap, yielding only broad envelopes of absorption and few distinctive features. FTIR analysis is expected to be particularly valuable in examining fire-cracked rock (FCR), for which few other means of analysis exist, since the fats, lipids, waxes, and other organic molecules contained in liquids that seep out of the food being processed become deposited on the rocks during the baking process. Once again, these rocks might have been present in more than one cooking episode, thus having the potential to yield a complex signature. The PRI extraction method gently removes these organic molecules from the groundstone, ceramics, and/or rocks so that they can be measured with the FTIR and subsequently identified.

Organic molecules from sediments can be extracted and the sediments then characterized. This has the potential to be very useful in identifying signatures of the remains responsible for a dark horizon. For instance, if the dark horizons are the result of decaying organic matter (plant or animal), the FTIR will yield a signature of decaying organic remains. If the dark horizons are the result of blowing ash from cultural features, the FTIR signature will be considerably different. This is an affordable technique for making distinctions between horizons and identifying cultural horizons.

Carbohydrates

Carbohydrates are a product of photosynthesis in green plants. This group of compounds is the most abundant found on earth. Carbohydrates is a term that encompasses three main groups of compounds: 1) sugars, 2) starches, and 3) fibers. To elaborate, sugars include the simple carbohydrates found in table sugar, honey, natural fruit sugars, and molasses. Starches and complex carbohydrates are present in legumes, grains, vegetables, and fruits. Fibers, including cellulose, hemicellulose, and pectin, are present in whole grains, legumes, vegetables, and fruits (Garrison and Somer 1985:13). Dietary carbohydrates provide energy for bodily functions, including our ability to digest and absorb other foods. They are the body's preferred source of energy, although proteins and lipids also may be converted to energy. Carbohydrates are so important that an inadequate intake may result in nutritional deficiencies such as ketosis, energy loss, depression, and even loss of essential body protein. On the other hand, excess intake of carbohydrates causes obesity and dental decay.

To understand carbohydrates and their detection with the FTIR, it is important to know that they are formed of carbon atoms coupled to "hyrates," such as water, resulting in empirical formulas of $C_nH_{2n}O_n$ where "n" represents the number of atoms for C, H, and O, respectively. "Biochemically, carbohydrates are polyhydroxy alcohols with aldehyde or ketone groups that are potentially active" (Garrison and Somer 1985:13). Since carbohydrates are classified according to their structure and the FTIR detects the bonds between molecules, we will review the simple sugars (monosaccharides), multiple sugars (oligosaccharides), and complex molecules (polysaccharides) that are made up of simple sugars.

Polysaccharides

These complex starchy compounds follow the empirical formula: $C_6H_{10}O_5$. They are not sweet, do not crystallize, and are not water soluble. Simply defined, polysaccharides are complex carbohydrates found in plants as starch and cellulose, and in animals as glycogen. Because the FTIR detects the bonds between atoms in molecules, it is important to know that polysaccharides are formed of repeating units of mono- or disaccharides that are joined together by glycosidic bonds. Polysaccharides are often heterogeneous. The slight modifications of the repeating unit results in slightly different wave number signatures on the FTIR. Types of polysaccharides are descriptive and include storage (starches and glycogen), structural (cellulose and chitin), acidic (containing carboxyl groups, phosphate groups, and/or sulfuric ester groups), neutral (presumably without the acid features), bacterial (macromolecules that include peptidoglycan, lipipolysaccharides, capsules and exopolysaccharides), and more. The study of polysaccharides is an ever growing field and industry, since polysaccharides are important to proper immune function, bowel health, and a host of other factors that are important in human health. At present there is no comprehensive study of which plants and animal parts contain which polysaccharides. Research into this field is currently growing at a rapid pace. Some highlights for the purpose of our discussions are presented below.

Storage Polysaccharides

Storage polysaccharides are digestible polysaccharides. Starch and glycogen are the two primary groups of these polysaccharides (Wardlaw and Insel 1996:80-81).

Starch

Starch is the primary digestible polysaccharide in the human diet, and the most important carbohydrate food source (Murray, et al. 2000:155; Wardlaw and Insel 1996:80). Starch is composed of long chains of glucose units. "Cooking increases the digestibility of...starches...making them more soluble in water and thus more available for attack by digestive enzymes" (Wardlaw and Insel 1996:80). Amorphous starch granules encased in cell walls burst free when cooked because the granules absorb water and expand. The two primary constituents of starch are amylose and amylopectin, both of which are a source of energy for plants and animals (Murray, et al. 2000:155; Wardlaw and Insel 1996:80). When the glucose chains are long and straight, the starch is labeled amylose. If the chains are short and branched, they are amylopectin. Shorter chains of glucose (dextrin) are the intermediate product of the hydrolysis of starch. Glucan, which is often found in association with pectin, resides in the cell walls of plants and trees and many forms of bacteria and fungi (Stephen 2006). Most people are familiar with beta glucans, which are a diverse group of molecules that occur commonly in the cellulose of plants, bran of cereals, cell walls of baker's yeast, and certain fungi, mushrooms, and bacteria. Some beta glucans may be useful as texturing agents and soluble fiber supplements. Beta glucans derived from yeast and medicinal mushrooms have been used for their ability to modulate the immune system.

Structural Polysaccharides

Structural polysaccharides, which are also known as dietary fiber, are indigestible by humans and other animals. Structural polysaccharides are primarily composed of cellulose, hemicellulose, pectin, gum, and mucilage (Wardlaw and Insel 1996:82). "The only noncarbohydrate components of dietary fiber are lignins, which are complex alcohol derivatives" (Wardlaw and Insel 1996:82). Lignins are complex alcohol derivatives that make up the non-carbohydrate components of insoluble plant fibers (Wardlaw and Insel 1996:82). As such, they cannot be digested by the enzymes animals produce (Carlile 1994). Lignin is found in all plants and is an important component of the secondary cell walls (Lebo, et al. 2001; Martone 2009; Wardlaw and Insel 1996:82). One of the important functions of lignin is to provide support through strengthening of the xylem cells of wood in trees (Arms 1995; Esau 1977; Wardrop 1969). In linking plant polysaccharides, lignin provides strength to the cell walls and by extension to the entire plant (Chabannes, et al. 2001). Because cellulose and chitin provide structural support to plants and animals they are not water soluble. Cellulose, hemicellulose, and pectin are all comprised of simple sugars, and their differences are defined by the various inclusions, exclusions, and combinations of these sugars, as well as how the sugars are bonded, and the molecular structure of the sugars of these polysaccharides.

Cellulose

Cellulose is comprised of a long linear chain of glucose, whereas hemicellulose consists of shorter branched chains of simple sugars in addition to glucose, including especially xylose, but also mannose, galactose, rhamnose, and arabinose (Crawford 1981; Updegraff 1969). Pectin, however, may be found in either a linear or branched form of simple sugars that is primarily composed of rhamnose.

Hemicellulose

Hemicellulose resides in the cell wall structures of many plants, particularly grain and vegetable plants, and is a component of both insoluble and soluble fibers (Wardlaw and Insel 1996:82). Some specific hemicelluloses include galactan, galactoglucomannan, glucomannan, glucuronoxylan (GX), and xyloglucan (Walker 2006; Wilkie 1985).

Galactoglucomannan. Galactoglucomannan is a primary component of the woody tissue of coniferous plants (Gymnosperms) (Bochicchio and Reicher 2003).

Glucomannan. Glucomannan, which may be very concentrated in some roots or corms and in the wood of conifers and dicotyledons (dicots), is a soluble fiber used to treat constipation by decreasing fecal transit time (Bochicchio and Reicher 2003; Marzio 1989).

Pectin, Gums, and Mucilages

Pectin, gums, and mucilages are soluble fibers found inside and around plant cells that help "glue" them together (Wardlaw and Insel 1996:82). Pectin is a structural heteropolysaccharide and common substance found in many plants (apples, plums, gooseberries, and citrus) often used for its gelling or thickening action. Plant derived gums and mucilages such as gum arabic, guar gum, and locus bean gum are also used for this same purpose. Arabinan, arabinogalactan, arabinoglucuronoxylan, and rhamnogalacturonan are some examples of these types of polysaccharides (Wilkie 1985).

Arabinoglucuronoxylan. Arabinoglucuronoxylan is found in the cell walls of softwoods and herbaceous plants (Sjostrom 1981).

<u>Neutral Polysaccharides</u>

These polysaccharides lack carboxyl groups, phosphate groups, and/or sulfuric ester groups. Examples of neutral polysaccharides cross other category boundaries of polysaccharides and include chitin, chitosan, curdlan, dextran, glucan, inulin, arabinogalactan, arabinogalactorhamnoglycan, and other compounds that often either are contained within individual plants or are the result of fermentation.

Arabinogalactorhamnoglycan

Arabinogalactorhamnoglycan is a specific polysaccharide, or complex carbohydrate, known as a neutral polysaccharide that is found in plant cell walls (Capek, et al. 1999; Kacurakova, et al. 2000). It exhibits peaks at 1049, 914, 837, and 810 wave numbers.

<u>Esters</u>

Esters are an important functional group because they are present as flavoring agents in food and are components of biological compounds such as fats, oils, and lipids. In an ester, the basic unit of the molecule is known as a carbonyl. The presence of the double peak between

3000 and 2800 wave numbers identifies the presence of the aldehyde functional group, which is present in fats, oils, lipids, and waxes.

There are two important groups of esters, saturated esters and aromatic esters. Aromatic esters take their name from their ability to produce distinctive odors and are present as flavoring agents in food. In contrast, saturated esters do not produce distinctive odors. Esters are expressed in the FTIR spectrum by three distinct peaks ("the rule of three") located at approximately 1700, 1200, and 1100 wave numbers, and a fourth peak in the region between 750 and 700 wave numbers, which represents the CH_2 bend associated with aromatic esters. The first peak for saturated esters falls in the 1750-1735 range, the second peak lies between 1210 and 1160, and the third peak sits between 1100 and 1030. Saturated esters have a unique peak to acetates at 1240. This band can be very strong in the signature. The first peak for aromatic esters falls in the range between 1730 and 1715, the second peak between 1310 and 1250, and the third peak between 1130 and 1100 (Smith 1999:110-112). Distinguishing between saturated and aromatic esters, which are both components of foods, is easy if all three bands are present, since they occupy different wave number regions.

Lipids

Lipids that are solid at room temperature are called "fats," and those that are liquid at room temperature are referred to as "oils" (Wardlaw and Insel 1996:108). Both forms of lipids can be detrimental, as well as beneficial, to human health. Consumption of certain animal fats rich in saturated fatty acids can lead to heart disease, while ingesting omega-3 fatty acids such as EPA (eicosapentaenoic acid) and DHA (docosahexaenoic acid) found in fish and other plant sources are essential to good health.

Fatty Acids

Fatty acids are found in most lipids in the human and animal body, as well as in the lipids in foods (Wardlaw and Insel 1996:108). Long chains of carbons bonded together which are then bonded to hydrogens define the structure of fatty acids (Wardlaw and Insel 1996:109). A fatty acid is considered saturated if the carbons are connected by single bonds. Saturated fatty acids are high in animal fats. If the carbon chain has one double bond between two of the carbons, then the fatty acid is monounsaturated. If there are two or more double bonds between carbons, then the fatty acid is polyunsaturated.

Essential Fatty Acids

Essential fatty acids, are those lipids critical to human health, such as omega-3 and omega-6 fatty acids, alpha-lineolic acid, and linoleic acid, that cannot be created within the body and must be obtained from dietary sources (Wardlaw and Insel 1996:110-111). These essential fatty acids are part of "vital body structures, perform vital roles in immune system function and vision, help form cell membranes, and produce hormone like compounds," and are necessary to maintain good health (Wardlaw and Insel 1996:111). Diets high in essential fatty acids, like omega-3 and omega-6, reduce the risk of heart attacks because they minimize the tendency for blood to clot (Wardlaw and Insel 1996:112). Fish oils contain high concentrations of omega-3 and omega-6 fatty acids and may be administered as a dietary supplement.

Proteins

The human body uses protein from dietary plant and animal sources to form body structures and other constituents (Wardlaw and Insel 1996:152). "Proteins contribute to key body functions, including blood clotting, fluid balance, production of hormones and enzymes, vision, and cell growth and repair" (Wardlaw and Insel 1996:152). This constant regulation and maintenance of the body requires thousands of different types of proteins that are not all available within the body (Wardlaw and Insel 1996:152). The majority of the building blocks for these proteins, which are also known as amino acids, are produced by plants.

Amino Acids

Within the body, amino acids are linked to form the necessary proteins, making them not only essential for life, but key to nutrition. Amino acids can be combined in a multitude of ways to create a vast variety of proteins. Differences between these proteins are distinguished by the unique arrangements of amino acids. Proteins are created through a process called translation, in which amino acids are added, one-by-one, to form short polymer chains called peptides, or longer chains called polypeptides or proteins (Rodnina 2007). The order in which the amino acids are added is determined by the genetic code of the mRNA template, which is a copy of an organism's genes (Creighton 1993). Amino acids are divided into standard and non-standard types.

Standard Amino Acids

There are twenty (20) naturally occurring amino acids on earth called standard amino acids (Creighton 1993). These amino acids are encoded by the standard genetic code and are found in all forms of life (Creighton 1993). The standard amino acids are broken down into two different types, essential and nonessential.

Essential Amino Acids

Eight of the standard amino acids are considered "essential amino acids" because they are necessary for normal human growth and cannot be synthesized by the human body (Young 1994). Essential amino acids must be obtained from food sources, and include histidine, isoleucine, leucine, lysine, methionine, phenylalanine, threonine, tryptophan, and valine (Furst and Stehle 2004; Reeds 2000; Wardlaw and Insel 1996:154).

Lysine. Lysine is important for calcium absorption, building muscle, recovering from injuries or illnesses, and the production of hormones, enzymes, and antibodies (Nelson and Cox 2005). Plants that contain significant amounts of lysine include legumes, gourds/squash, spinach, amaranth, quinoa, and buckwheat (Wardlaw and Insel 1996:158). Other dietary sources of lysine include beef, poultry, pork, fish, eggs, and dairy.

Nonessential Amino Acids

The majority of the standard amino acids are considered "nonessential," meaning that under normal circumstances these amino acids can be manufactured by the human body and are not required in the diet. However, some amino acids that are normally nonessential may become an essential part of the diet for a person whose health has been compromised

(Wardlaw and Insel 1996:155). Nonessential amino acids include alanine, arginine, asparagine, aspartate (aspartic acid), cysteine, glutamate (glutamic acid), glutamine, glycine, proline, serine, and tyrosine (Furst and Stehle 2004; Reeds 2000)(Wardlaw and Insel 1996:154).

Alanine. Alanine plays an important role in the glucose-alanine cycle between tissues and liver (Nelson and Cox 2005). Common sources of alanine in the diet include such diverse things as meat, eggs, fish, legumes, nuts and seeds, and maize.

Aspartate. Aspartate, also known as aspartic acid, is an important neurotransmitter in the brain (Nelson and Cox 2005). Common sources of aspartate include wild game, meat, oats, avocado, asparagus, and sprouted seeds.

Glutamate. Glutamate, or glutamic acid, is an important molecule in cellular metabolism. It is the most abundant excitatory neurotransmitter in the nervous system of mammals (Nelson and Cox 2005). Glutamate is found in dairy products, eggs, and all meats, such as beef, pork, poultry, wild meats, and fish (Reeds, et al. 2000).

Serine. Serine is important in metabolic function (Nelson and Cox 2005). It serves as a neuronal signal by activating N-methyl-D-aspartate (NMDA) receptors in the brain and helps to build muscle tissue (Mothet, et al. 2000). Common sources of serine in the diet are beef, eggs, nuts and seeds, legumes, and milk.

<u>Nonstandard Amino Acids</u>

Nonstandard amino acids are amino acids that are chemically altered after they have been incorporated into a protein and/or amino acids that exist in living organisms but are not found in proteins (Driscoll 2003).

Nucleic Acids

Millions of proteins exist in all living organisms to assist with the daily functions of these complex systems. Proteins are produced and assembled locally to exact specifications, and a large amount of information is necessary to properly manage the system. This information is stored in a set of molecules called nucleic acids. Nucleic acids not only contain the genetic instructions for the proper development and functioning of living organisms, but also play a role in copying genetic information to protein (Saenger 1984). The most common examples of nucleic acids are DNA (deoxyribonucleic acid) and RNA (ribonucleic acid).

ETHNOBOTANIC REVIEW

It is a commonly accepted practice in archaeological studies to reference ethnographically documented plant uses as indicators of possible or even probable plant uses in prehistoric times. The ethnobotanic literature provides evidence for the exploitation of numerous plants in historic times, both by broad categories and by specific example. Evidence for exploitation from numerous sources can suggest widespread utilization, and strengthens the possibility that the same or similar resources were used in prehistoric times. Ethnographic sources outside the study area have been consulted to permit a more exhaustive review of potential uses for each plant. Ethnographic sources document that with some plants, the historic use was developed and carried from the past. A plant with medicinal qualities very likely was discovered in prehistoric times and the usage persisted into historic times. There is, however, likely to have been a loss of knowledge concerning the utilization of plant resources as cultures moved from subsistence to agricultural economies and/or were introduced to European foods during the historic period. The ethnobotanic literature serves only as a guide indicating that the potential for utilization existed in prehistoric times--not as conclusive evidence that the resources were used. Pollen and macrofloral remains, when compared with the material culture (artifacts and features) recovered by the archaeologists, can become indicators of use. Plants represented by organic residues will be discussed in the following paragraphs in order to provide an ethnobotanic background for discussing the remains.

Native Plants

Agavaceae (Agave Family)

Agavaceae are perennial plants, that are typically found in the foothills and lower mountain areas of the Southwest }(Castetter, et al. 1938:79). Members of the agave family were utilized in a variety of food and fiber applications by native peoples of the Southwest. The crowns of *Agave* (agave, century plant, mescal) species were commonly collected and roasted in pits. Roasted agave could be consumed immediately, or further prepared by boiling or pounding into a paste. Fermented agave beverages were a later introduction to the Southwest, by way of Mexico and Mesoamerica. Fibers from members of the Agavaceae family, particularly those of *Yucca* species, were used to make cloth, sandals, baskets, rope, and a variety of other utilitarian items. Roots of *Yucca* species have a high saponin content, and were processed by groups throughout the Southwest to produce a soap for washing. *Yucca* species were also a source for edible seeds and fleshy fruits. (Bell and Castetter 1941; Castetter, et al. 1938:78; Ebeling 1986:468-474; Luomala 1978).

Atriplex (Saltbush)

Atriplex (saltbush) was exploited for both its greens (cooked as potherbs) and seeds. The seeds were ground and sometimes mixed with cornmeal to make a variety of mushes and cakes. The seeds were parched and ground into a meal. *Atriplex* meal was sometimes used to make a salty pinole. *Atriplex* leaves and young shoots also have a salty taste and were cooked as greens or added to meat and other vegetables for its salty flavor. The leaves also were boiled in water, then strained and fried in grease. Leaves were rubbed in water to produce a lather for washing clothes and baskets. The dried tops of *A. canescens* (four-wing saltbush) were used to make a tea for treating nausea and vomiting from the flu. A hot tea was taken for breaking fevers, while a cold tea is used to treat stomachs (Moore 1990:29). The Hopi used ashes of *A. canescens* as a substitute for baking powder. The Tewa at Hano are noted to have used saltbush ashes to color cornmeal (Robbins, et al. 1916:54). *Atriplex* ashes also were used to make hominy. *Atriplex* leaves, twigs, and blossoms yielded a bright yellow dye (Bryan and Young 1978:32). The wood was a source of firewood (Curtin 1984:66-69; Kearney and Peebles 1960:225; Whiting 1939:18, 22, 73). *Atriplex* are annual or perennial, herbaceous or shrubby plants found in arid, alkaline, or saline soil (Kirk 1975:59).

Cylindropuntia (Cholla Cactus)

Cylindropuntia is an antiquated term for cholla cactus that has been applied in palynology to distinguish cholla cactus from prickly pear cactus (*Opuntia*). Cholla buds are collected during the spring and roasted. The buds are available in May and the fruit ripens later in the summer. The cooked buds can be dried and later ground. Cholla fruits and joints also were collected for consumption. The yellow, spineless cholla fruits were worn around the neck as a charm or placed around a dwelling to keep away diseases. Boiled cholla roots are reported to have been used as an infant laxative (Buskirk 1949:320-321; Gallagher 1977:92; Greenhouse, et al. 1981; Hrdliçka 1908:231; Kearney and Peebles 1960:581-586).

Poaceae (Grass Family)

Members of the Poaceae (grass) family, such as *Oryzopsis* (Indian rice grass) and *Sporobolus* (dropseed), have been widely used as a food resource. Seeds could be eaten raw, but were usually parched and ground into a flour that could be combined with other flours and ground meal to make breads and mushes. Young shoots and leaves might have been cooked as greens. Grass also is reported to have been used as a floor covering and to make hairbrushes and brooms. Various grasses also were used in the manufacture or decoration of pahos (prayer sticks) and for various ceremonial purposes. Grass seeds ripen from spring to fall, depending on the species, providing a long-term available resource (Chamberlin 1964:372; Colton 1974:338, 365; Cushing 1920:219, 253-254; Elmore 1944:24-27; Robbins, et al. 1916; Rogers 1980:32-40; Vestal 1952:15-18; Whiting 1939:65).

Quercus (Oak)

Quercus (oak) are deciduous or evergreen shrubs to large trees, and the various species are widespread throughout the United States. All species of *Quercus* produce edible acorns, although the presence of tannin results in varying degrees of bitterness. White oak acorns are generally less bitter than black oak (including red oak) acorns. The acorns of *Q. gambelii* (Gambel's oak, Rocky Mountain white oak) are noted to be the least bitter of all; sometimes they are able to be eaten fresh. Gambell's oak is the most common oak of the southern Rocky Mountain region. Other species of acorn are palatable only after the bitter taste has been removed. Acorns are noted to have been utilized by native peoples in the Southwest. Acorns were gathered, shelled, roasted, and ground into a meal. The ground meal most often was leached with water in various ways to remove the bitter taste. Wood ashes could be used like lye in the leaching process. The ground meal was used alone or mixed with cornmeal to make mush, thicken soup, or make breads and cakes. Acorn meal also could be mixed with meat or animal fat. Oak wood was used for a variety of utilitarian purposes including making bows, arrows, rabbit sticks, digging sticks, clubs, and other utensils. Oak wood is strong and hard, and it was valued as firewood because a large piece of oak would burn slowly all night long. Oak bark was the principal source of tanning materials. Oaks in the southwestern United States can be found in dry soils in canyons and foothills (Elmore 1944:23; Gallagher 1977:113; Harrington 1967:239-241; Kearney and Peebles 1960:216-217; Kirk 1975:104-106; Vines 1960:162; Whiting 1939:72).

Cultigens

Cucurbita (Squash/Pumpkin/Gourd)

Cucurbita (squash/pumpkin/gourd) is noted as one of the most important New World crops, and, along with corn and beans, belongs to what Ford (1981) has called the *Upper Sonoran Agricultural Complex* (Cordell 1984:171). These crops were the first to be cultivated everywhere in the Southwest. Fresh squash were cut into pieces, boiled, baked, or roasted whole in ashes. Squash and pumpkins also were cut in coils or strips that were dried for future use. Blossoms were used to season soup or fried in grease and used as a delicacy in combination with other foods. Seeds also were roasted and eaten or used to oil piki stones. Gourds were dried and made into cups, ladles, dippers, ceremonial rattles, and used for other purposes (Cordell 1984:178; Cushing 1920:561; Elmore 1944:79; Robbins, et al. 1916:100-102; Vestal 1952:46-47; Whiting 1939:93).

Zea mays (Maize, Corn)

Zea mays (maize, corn) has been an important New World cultigen, originating from a wild grass called teosinte. Maize has long been a staple of the Southwest inhabitants, and charred maize is found in almost every cliffhouse in the Southwest (Stevenson 1915:73). Various colors of maize were grown, including white, yellow, blue, red, black, and a combination of these. Innumerable ways of preparing maize exist. Green corn was widely used, and ears were collected from the regular fields. Mature ears were eaten roasted or wrapped in corn husks and boiled. The kernels could be parched, soaked in water with juniper ash, and boiled to make hominy. Dried kernels could be ground into meal, which was used as a staple. Cornmeal could be colored with *Atriplex* ashes. Black corn was used as a dye for basketry and textiles and as a body paint. Maize could be husked immediately upon harvesting, and the clean husks were saved for smoking and other uses, such as wrapping food. Ears also could be allowed to dry on the roof, and ristras of maize could be hung inside from the roof. Whole ears and/or shelled kernels were stored for future use. Corn pollen was widely used in various rituals and ceremonies (Cushing 1920:264-267; Robbins, et al. 1916:83-93; Stevenson 1915:73-76; Vestal 1952:18-19; Whiting 1939:67-70).

DISCUSSION

Site LA5148 is a prehistoric archaeological site located on a low rise adjacent to a playa in the Laguna Plata Archaeological District of Lea County northeast of Carlsbad, New Mexico. Local vegetation consists of *Prosopis* (mesquite), *Larrea tridentata* (creosote), and grasses (Poaceae). At least one pit house has been identified at the site (Feature 3). Groundstone recovered from this feature and from the modern surface was tested for organic residues using Fourier Transform Infrared Spectroscopy (FTIR) (Table 1). Organic residue analysis also was performed on a unimarginal flake stone tool and a unifacial flaked stone tool found on the modern surface, as well as a Jornada brown ceramic sherd and a South Pecos ceramic fragment. Results from these analyses will be discussed below by artifact type.

Groundstone

Feature 3

Feature 3 is an irregularly-shaped pit house with a shallow basin profile (Peter Condon, personal communication, November 22, 2010). Nineteen post holes, three wooden posts, and charcoal were recovered from this feature along with groundstone, and projectile point and ceramic assemblages. Radiocarbon dating of charred wood fragments from two of the wooden posts returned dates of 900 ± 25 BP (UGA 6725) with a calibrated age range of AD 1040 and AD 1220; and 870 ± 28 BP (UGA 7215) with a calibrated age range of AD 1040 and 1220 (Peter Condon, personal communication, November 22, 2010).

Organic residue analysis of a groundstone fragment from Feature 3 (sample 6) yielded peaks representing major categories (functional groups) of compounds in the 4000-1500 wave number range of the spectrum, as well as specific compounds noted in the fingerprint region (1500-400 wave numbers) of the spectrum. The functional group peaks indicate the presence of absorbed water and fats/oils/lipids and/or plant waxes (Table 2). Peaks within the fingerprint region represent the presence of aromatic rings; aromatic esters; proteins including nucleic acids; the amino acid lysine; calcium carbonate; cellulose and carbohydrates; and polysaccharides including arabinose, glucomannan, and galactoglucomannan.

Matches with these peaks were made with calcium carbonate and deteriorated cellulose indicating the sample is dominated by an environmental signal (Table 3). Calcium carbonate in the sample is consistent with alkaline sediments in the area, while matches with deteriorated cellulose probably reflect deterioration of natural vegetation. Alternatively, the presence of cellulose in the sample might indicate other plants processed that have decayed to the point they are only visible by their general cellulose signature. Peaks representing calcium carbonate also are present in the signature for this sample. Due to the ubiquitous nature of these matches and peaks, a complete restatement of their significance will not be made for each groundstone sample.

Peaks representing calcium carbonate and arabinose, a polysaccharide, are located very close to one another at 873 wave numbers. If this peak represents arabinose, a polysaccharide found in maize, it suggests possible processing of this cultigen with the groundstone. If, on the other hand, it represents calcium carbonate, then there is no secure evidence for processing maize at this location. Peaks around 873 wave numbers are visible in all of the groundstone samples, the importance of these peaks will not be reiterated for each sample.

Peaks representing the amino acid lysine suggest the presence of legumes, gourd/squash, and/or meat in the sample, and might suggest processing any or all of these foods. These peaks are present in all samples from this site and their significance will not be repeated for each sample.

Glucomannan and galactoglucomannan also are visible in the majority of the samples from this project and their significance also will not be readdressed for each sample. The presence of these polysaccharides suggests woody and fibrous tissues including those from coniferous plants and/or dicotyledons are contributing to the signature. These compounds might indicate cultural utilization of specific woods or they could be attributable to plants growing in the local environment.

Two groundstones from the ground surface at the site were sampled (50 and 52) for organic residues. Sample 50, representing the first groundstone, yielded functional group peaks indicating the presence of absorbed water and fats/oils/lipids and/or plant waxes. Peaks in the fingerprint region represent aromatic rings; aromatic esters; protein; the amino acid lysine; pectin; calcium carbonate; and polysaccharides including arabinose, glucomannan, and galactoglucomannan.

This signal was matched with calcium carbonate and deteriorated cellulose. These matches suggest the presence of a strong environmental signal.

The second groundstone sample from the surface (sample 52) yielded peaks representing functional group compounds including absorbed water and fats/oils/lipids and/or plant waxes. Other peaks identified in the fingerprint range indicate the presence of aromatic and saturated esters; protein; the amino acid lysine; pectin; calcium carbonate; calcium oxalates; humates; starch; cellulose and carbohydrates; and polysaccharides including arabinose, arabinoglucuronoxylan, glucomannan, and galactoglucomannan.

The signal representing this groundstone matched with raw *Agave* leaf pulp, baked *Agave* leaf skin, *Atriplex* (saltbush) fruit, baked *Cylindropuntia* (cholla) buds, *Quercus* (acorn) nutmeat, and grass seeds suggesting agave, saltbush, cholla cactus, acorn, and grass were ground with this tool.

Peaks indicating calcium oxalates in the sample support processing of agave, saltbush, and/or cholla cactus, and perhaps other locally available plants containing these crystals including *Yucca* and other members of the Cactaceae (cactus family) and Chenopodiaceae (goosefoot family). The possibility that calcium oxalates are present and detectable might also reflect deterioration of plant matter from local vegetation that included these plants.

Other matches in the fats/lipids and cellulose peak areas were made with dried, ground *Zea mays* (maize) kernels. Since both the fats/lipids and cellulose peaks are considered to be very general indicators of plant remains, neither of these peak areas can be considered to be an accurate identifier of foods processed. Therefore, in spite of the match with these peaks, the absence of matches with other, more definitive peaks for maize, indicates that any interpretation of processing maize with this tool should be rejected at this time. Although the presence of a peak representing the polysaccharide arabinose is common for maize; this compound also has been reported in the cell walls of some grasses (Migne, et al.1998) and it is noted as a constituent of *Opuntia* leaf mucilages (Clifford et al 2002:135) and in *Prosopis* and *Opuntia* gums (Krochmal et al 1954:6, 16-17). Since arabinose has been targeted as a nutriceutical or important nutritional compound, much research is available concerning its identification, including it’s expected FTIR signature. The match with *Zea mays* hinges on the presence of arabinose and is not diagnostic of the presence of this cultivated plant. Instead, it is very likely that this peak represents arabinose in plants found growing in the local environment.

Matches with calcium carbonate and deteriorated cellulose probably are part of the local environmental signal.

Peaks indicating the polysaccharide arabinoglucuronoxylan, which is found in the cell walls of all softwoods and herbaceous plants (Sjostrom 1981), likely reflect a combination of cultural activities and environmental processes that occurred at the site.

Lithics

A unimarginal lithic tool recovered from the surface was tested (sample 38) for organic residues. Sample 38 yielded functional group peaks indicating the presence of amines and fats/oils/lipids and/or plant waxes. Peaks within the fingerprint range of the spectrum represent aromatic rings; aromatic esters; protein; the amino acids aspartate, lysine, and serine; pectin; humates; cellulose and carbohydrates; starch; and the polysaccharides arabinogalactorhamnoglycan and glucan.

Matches with this signature were made with Creosote (*Larrea tridentata*) leaves, twigs, and seeds. These matches probably reflect plants growing in the local environment, and not cultural utilization.

Contributions to the signal from meat are indicated by peaks representing aspartate and serine. The presence of these amino acids in the sample might represent either natural decomposition of faunal remains or possibly animal processing.

Peaks representing amines, which are produced by the breakdown of amino acids through plant and animal decomposition (Guch and Wayman 2007:176), probably are attributable to either the cultural or environmental signal (or both) of the sample, as these compounds are not unique to either natural processes or cultural activities. Amine peaks are present in both lithic samples and their significance will not be restated for each sample.

Other peaks representing the polysaccharides arabinogalactorhamnoglycan (Kacurakova, et al. 2000) and glucan (Stephen 2006) likely also result from the natural decomposition and cultural utilization of different plants. These compounds are found in many plants and cannot be used to identify specific species.

FTIR analysis also was performed on a unifacial lithic tool found on the ground surface (sample 42). This sample (42) yielded peaks representing functional group compounds including amines and fats/oils/lipids and/or plant waxes. Other peaks in the fingerprint region indicate the presence of aromatic and saturated esters; protein; the amino acid lysine; humates; and the polysaccharides arabinoglucuronoxylan, glucomannan, and galactoglucomannan.

No good matches were made with the signal obtained from this lithic tool for any of the references in the PaleoResearch and forensic libraries; however, matches with peaks in only the fats and lipids portion of the spectrum between 3000 and 2800 wave numbers suggest non-specific plant and animal materials are contributing to this range. The only other significant peak visible in the sample was a high amplitude peak at 942 wave numbers representing the polysaccharide glucomannan. This compound suggests the sample is heavily influenced by the presence of woody and fibrous tissues from conifers and dicotyledons (dicots). These plants probably reflect the local vegetation, but might also indicate plants processed using this tool. Contributions to the signal from conifers might further be supported by a small, low amplitude peak at 1109 wave numbers representing another polysaccharide galactoglucomman.

The peak at 1109 wave numbers also indicates arabinoglucuronoxylan. This polysaccharide suggests the presence of softwoods and herbaceous plants in the sample. Again, the inability to assign this compound to a specific plant species suggests arabinoglucuronoxylan in the sample could be attributable to a combination of natural processes and cultural activities.

Ceramics

Organic residue analysis of a Jornada brown ceramic sherd (sample 206) yielded functional group peaks indicating the presence of absorbed water and fats/oils/lipids and/or plant waxes. Peaks within the fingerprint range of the spectrum representing aromatic and saturated esters; proteins including nucleic acids; the amino acids lysine and glutamate; pectin; humates; cellulose and carbohydrates also were noted.

Matches with these peaks were made with *Cucurbita* (gourd/pumpkin/squash) flesh, *Quercus* (acorn) nutshells, and cooked rabbit suggesting acorns, gourd/pumpkin/squash, and meat were contained and/or processed in the ceramic vessel represented by this sherd. Although a match is made with rabbit, it is interpreted at a general, rather than specific, level, meaning that although it appears the inhabitants of the site were processing meat, the particular species or types of animals that were being utilized cannot be identified. It should be noted, though, that due to the ubiquity of rabbits in the area, the probability that rabbits were hunted for food is high. Identification of raw protein using protein residue analysis, which is based on immunological techniques, is the only method to identify specific animal proteins.

Peaks representing the amino acid glutamate support the presence of meat in the sample. Identification of this peak, combined with the match to rabbit (reported above) are important in distinguishing between cooking meat in the vessel represented by this ceramic and accidental contamination of the ceramic after deposition by animal urine and/or feces.

The matches with *Cucurbita* flesh from cultivated squash for this sample probably reflect the use of cultivated gourds, squash, and/or pumpkin rather than those of a wild variety. Overlay of the reference signatures for the cultivated and wild species reveals significant differences in peaks represented in the protein, pectin, cellulose, and carbohydrate portions of the spectrum.

Other matches with deteriorated cellulose probably represent the natural decay of plants in the local environment; however, the presence of cellulose also could indicate non-specific plant processing using the ceramic vessel.

A South Pecos ceramic sherd tested (sample 580) for organic residues yielded peaks representing functional group compounds including absorbed water and fats/oils/lipids and/or plant waxes. Peaks identified in the fingerprint region indicate the presence of aromatic and saturated esters; protein; pectin; the amino acids lysine and glutamate; humates; and the polysaccharide galactoglucomannan.

No good matches were made from the signal obtained from the South Pecos ceramic sherd with references in the PaleoResearch or forensic libraries. Non-specific plants and animals were matched with the fats and lipids portion of the spectrum suggesting these materials are contributing to the peaks at this range. The only other significant, high amplitude peak visible in the sample occurs at approximately 935/934 wave numbers. This peak represents the polysaccharide galactoglucomannan, which is a primary component of the woody tissue of coniferous plants (Gymnosperms) (Bochicchio and Reicher 2003). The indication of glucomannan with a prominent peak in the signal suggests the sample is dominated by these types of plants, which probably reflect the local vegetation.

A smaller, low amplitude peak indicating the amino acid glutamate also is visible in this ceramic sample. The presence of this compound might indicate meat was contained in the vessel despite the absence of matches with mammal references; however, given the relative size of this peak it is more likely attributable to the natural decay of faunal remains in the sediments from which the sherd was recovered.

SUMMARY AND CONCLUSIONS

Organic residue analysis of one of the the groundstone (sample 52) from site LA5148 produced the most prolific and unique signature of the tools examined. Peaks that matched with agave, saltbush, cholla cactus, grass seeds, nuts, and maize were identified. This signal is somewhat anomalous in the variety of peaks present. Close examination of these peaks indicates that the only matches with maize were unspecific fats/lipids and cellulose, which are not sufficient to sustain an interpretation of grinding maize. They do, however, point to the presence of a signature derived from plant parts containing fats/lipids and cellulose, which is true of many seeds. The signatures from the other two groundstones (samples 6 and 50) exhibited strong environmental signals detecting calcium carbonate and deteriorated cellulose in the sediments and are quite different from the signature obtained from sample 52. The presence of cellulose in the samples also could suggest processing of plants that have deteriorated to the point they are visible only by their general cellulose signature. It is likely that pollen and starch analysis would provide more information concerning use of these groundstones.

The FTIR record for the lithic tools (samples 38 and 40) yielded evidence of only an environmental signal. The unimarginal tool (sample 38) matched directly with creosote, while the unifacial tool (sample 40) returned no matches, and only peaks suggesting non-specific contributions from decomposing flora and fauna, likely derived from the local environment, and not cultural utilization.

Examination of the organic residues from the ceramic sherds suggests the vessel represented by sample 206 was used to contain and/or prepare acorn; cultivated gourd, pumpkin, and/or squash; and meat, probably from rabbits. No matches were made with the sample (580) representing the other ceramic sherd from the site. Peaks visible in the signature indicating specific amino acids and polysaccharides suggest contributions from unidentifiable plant and animal materials, probably reflecting the environmental signal.

TABLE 1
PROVENIENCE DATA FOR SAMPLES FROM SITE LA5148, LEA COUNTY, NEW MEXICO

Sample Number	Feature	Unit	Strat	Depth	Provenience/Description	Analysis
6	3	2	II		Groundstone fragment	FTIR
50				surface	Groundstone fragment	FTIR
52				surface	Groundstone	FTIR
38				surface	Unimarginal lithic tool	FTIR
42				surface	Unifacial lithic tool	FTIR
206		D-20			Jornada brown ceramic sherd	FTIR
580		D-20			South Pecos ceramic sherd	FTIR

FTIR = Fourier Transform Infrared Spectrometry

TABLE 2
FTIR PEAK SUMMARY TABLE FOR SAMPLES FROM SITE LA5148, LEA COUNTY, NEW MEXICO

Peak Range	Represents	6 GS	50 GS	52 GS	38 Lithic	42 Lithic	206 Ceramic	580 Ceramic
3600-3200	Absorbed Water (O-H Stretch)	3393,3386	3358	3339			3352	3354
3500-3300 sharp	Amines				3393,3392	3393		
3300-3100	Proteins (N-H Stretch)					3189		
3000-2800	Aldehydes: fats, oils, lipids, waxes	2922, 2849	2921, 2851	2924, 2854,2853	2954, 2920 2851	2920, 2850	2922, 2852	2921, 2851
2959, 2938, 2936, 2934, 2931, 2930, 2926, 2924, 2922	CH_2 Asymmetric stretch	2922	2921	2924			2922	2921
1750-1730	Saturated esters (C=O Stretch)			1741		1736	1735	1735
1742	Lipids (Triglycerides, C=O Stretch)			1741				
1737	Lipids (Phosphopilids, C=O Stretch)					1736		
1720	Aspartate (amino acid) C=O bending				1719			

TABLE 2 (Continued)

Peak Range	Represents	6 GS	50 GS	52 GS	38 Lithic	42 Lithic	206 Ceramic	580 Ceramic
1730-1705	Aromatic esters (C=O Stretch)				1719			
1700-1500	Protein, incl. 1650 protein	1655, 1625,1624	1654,1637, 1618	1637, 1629, 1560	1625,1624, 1603, 1577,1540, 1512	1645, 1629	1655/54, 1637, 1577/60, 1541	1654,1648, 1637, 1577,1560, 1541
1653	Proteins (Amide bands, 80% C=O Stretch, 10% C-N Stretch, 10% N-H Bend)		1654				1654	1654
1680-1600, 1260, 955	Pectin		1654,1637, 1618	1637,1629	1625,1624, 1603		1655/54, 1637	1654,1648, 1637
1660-1655	Proteins, Nucleic acids	1655					1655	
1640-1610, 1550-1485, 1160, 1100	Lysine (amino acid) NH_3^+ bending Lysine (amino acid) NH_3^+ rocking	1625,1624	1637,1618, 1508	1637,1629 1161	1625,1624, 1540,1512	1629	1637, 1541	1637, 1541
1560	Glutamate (amino acid) CO_2^- asymmetric stretching						1560	1560

TABLE 2 (Continued)

Peak Range	Represents	6 GS	50 GS	52 GS	38 Lithic	42 Lithic	206 Ceramic	580 Ceramic
1500-1400	Protein	1420	1425,1420	1416,1415	1490,1466, 1459,1444, 1421,1420	1467, 1420	1459, 1420	1459, 1420
1465-1455	Protein/lipids							1459
1465	Alanine (amino acid) CH_2 bending				1466			
1490-1350	Protein	1420	1425,1420	1416,1415, 1378	1490,1466, 1459,1444, 1421,1420	1467, 1420, 1377	1459, 1420, 1377	1459, 1420, 1376
1394, 1379, 1366	Split CH3 umbrella mode, 1:2 intensity			1378				
1377	Fats, oils, lipids, humates (CH_3 symmetric bend)			1378	1377, 1376	1377	1377	1376
1350-1250	Serine (amino acid) O-H bending				1343, 1342			
1238	Aromatic ether C-O stretch			1240,1239				
1170-1150, 1050, 1030	Cellulose			1163,1161	1164			
1162	Cellulose			1161				

TABLE 2 (Continued)

Peak Range	Represents	6 GS	50 GS	52 GS	38 Lithic	42 Lithic	206 Ceramic	580 Ceramic
1161, 1151	Arabinoglucuro-noxylan + Galactogluco-mannan			1161				
1130-1100	Aromatic esters				1112	1109		
1109	Arabinoglucuro-noxylan + Galactogluco-mannan					1109		
1028-1000	Cellulose Carbohydrates	1004		1027,1008	1028		1008	
1028	Ester O-C-C stretch			1027	1028			
1026	Starch			1027				
969	C-C-C Stretch				968			
941	Glucomannan					942		
934	Galactogluco-mannan							935
931	Starch				932			
914	C-C-C Stretch				914			
914	Arabinogalactor-hamnoglycan				914			

TABLE 2 (Continued)

Peak Range	Represents	6 GS	50 GS	52 GS	38 Lithic	42 Lithic	206 Ceramic	580 Ceramic
874	Polysaccharides	873	873	873				
872	$CaCO_3$	873	872	872				
872	+Glucomannan (9:1, w/w), Glucomannan, Galactogluco-mannan	873	872	872				
840	Glucan				839			
780	Calcium oxalate			780				
750-700	Aromatic esters	712	712	727,724, 713,712	747,746	721	722	722
763, 760, 745, 737, 736	Aromatic out-of-plane C-H bend				746			
722-719	CH_2 Rock (methylene)					721	722	722
699-697	Aromatic ring bend				699			
692	Aromatic ring bend (phenyl ether)	694	693					

GS = Groundstone

TABLE 3
MATCHES SUMMARY TABLE FOR FTIR RESULTS FROM SITE LA5148, LEA COUNTY, NEW MEXICO

Match (Scientific Name)	Match (Common Name)	Part	6 GS (Range)	50 GS (Range)	52 GS (Range)	38 Lithic (Range)	206 Ceramic (Range)
CULTURAL							
Agave	Agave	Leaf pulp (raw)			1263-1216		
		Leaf skin (baked)			1189-1129 797-767		
Atriplex	Saltbush	Fruit			1183-1147		
Cucurbita	Gourd/Pumpkin/ Squash	Flesh					1490-1392 1392-1335
Cylindropuntia	Cholla cactus	Bud (baked)			1189-1129		
Poaceae	Grass family	Seed			1263-1216		
Quercus	Acorn	Nutmeat			3000-2800 1771-1703		
		Nutshell					1401-1347
Zea mays	Maize	Kernel (dried, ground)			3000-2800 1189-1129		
Mammalia	Rabbit	Meat (cooked)					1756-1688 1670-1646 806-764

TABLE 3 (Continued)

Match (Scientific Name)	Match (Common Name)	Part	6 GS (Range)	50 GS (Range)	52 GS (Range)	38 Lithic (Range)	206 Ceramic (Range)
ENVIRONMENTAL							
Calcium Carbonate	Calcium carbonate		1440-1404 717-705	887-857 720-708	1440-1398		
Deteriorated Cellulose	Deteriorated cellulose		1234-893	1228-1003 824-785	1078-947		1228-1004
Larrea tridentata	Creosote	Seed				1610-1589	
		Twig				1610-1589 1171-1153	
		Leaf				1610-1589 1171-1153	

GS = Groundstone

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Appendix G: XRF Obsidian Analysis

BERKELEY ARCHAEOLOGICAL XRF LAB

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LETTER REPORT

AN ENERGY-DISPERSIVE X-RAY FLUORESCENCE ANALYSIS OF OBSIDIAN ARTIFACTS FROM LA 5148, LEA COUNTY, SOUTHEASTERN NEW MEXICO

15 July 2010

Peter Condon
TRC
5400 Suncrest Drive, Suite D-1
El Paso, TX 79912

Dear Peter,

I'm sorry this took so long. I just returned from my field school in New Mexico. The artifacts were all produced from one of the three main sources in the Jemez Mountains, El Rechuelos, Cerro Toledo Rhyolite, and Valles Rhyolite, the former two readily available in the Rio Grande Quaternary alluvium (Shackley 2005; Table 1 and Figure 1 here). Valles Rhyolite has been found as far south as Albuquerque, but in very small nodule sizes (< 16 mm), and in proportions well below 1% (LeTourneau and Shackley 2009; Shackley 2010).

The samples were analyzed with a Thermo Scientific *Quant'X* EDXRF spectrometer in the Archaeological XRF Laboratory, El Cerrito, California. Specific instrumental methods can be found at http://www.swxrflab.net/anlysis.htm, and Shackley (2005). Samples assigned to source by comparison to source standards at Berkeley (Shackley 2005). Analysis of the USGS RGM-1 standard indicates high machine precision for the elements of interest (Table 1 here).

Sincerely,

M. Steven Shackley, Ph.D.
Director

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2010 The Secondary Distribution of Archaeological Obsidian in Rio Grande Quaternary Sediments, Jemez Mountains to San Antonito, New Mexico (in preparation).

Table 1. Elemental concentrations for the archaeological samples. All measurements in parts per million (ppm).

Sample	Ti	Mn	Fe	Rb	Sr	Y	Zr	Nb	Source
11	713	416	9631	171	7	45	172	54	Valles Rhyolite
16	1136	556	10569	216	3	62	168	94	Cerro Toledo Rhy
32	1223	446	8699	184	3	52	149	87	Cerro Toledo Rhy
48	1017	499	9327	202	5	57	162	89	Cerro Toledo Rhy
113	587	540	9874	217	6	65	172	94	Cerro Toledo Rhy
260	597	579	10193	231	4	66	177	97	Cerro Toledo Rhy
RGM1-S5	1604	289	12905	150	106	25	212	10	standard

Appendix H: INAA Ceramic Analysis

Archaeometry Laboratory

Instrumental Neutron Activation Analysis of Mogollon Brownware and Chupadero Black-on-white ceramics from the Laguna Plata Site (LA49917) in Lea County, New Mexico

Report Prepared by:
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November 11, 2010

Introduction

This project involves the analysis of 16 sherds from the Laguna Plata Site (LA5148) in southeastern New Mexico. Twelve of the samples are various types of Mogollon Brownware and four are Chupadero Black-on-white. The primary goal of this research is to compare these samples to the extensive database of comparable ceramics previously analyzed at MURR. The four Chupadero samples fit will into groups previously established from the Salinas District and Capitan Mountains. The Mogollon Brownware samples fit into a much more complex database that is currently undergoing a complete reinterpretation (Miller and Ferguson 2010). The results are preliminary, but nine of the twelve Brownware samples fit preliminary groups with proposed production areas.

Sample Preparation

Pottery samples were prepared for INAA using procedures standard at MURR. Fragments of about 1cm^2 were removed from each sample and abraded using a silicon carbide burr in order to remove glaze, slip, paint, and adhering soil, thereby reducing the risk of measuring contamination. The samples were washed in deionized water and allowed to dry in the laboratory. Once dry, the individual sherds were ground to powder in an agate mortar to homogenize the samples. Archival samples were retained from each sherd (when possible) for future research.

Two analytical samples were prepared from each source specimen. Portions of approximately 150 mg of powder were weighed into clean high-density polyethylene vials used for short irradiations at MURR. At the same time, 200 mg of each sample was weighed into clean high-purity quartz vials used for long irradiations. Individual sample weights were recorded to the nearest 0.01 mg using an analytical balance. Both vials were sealed prior to irradiation. Along with the unknown samples, Standards made from National Institute of Standards and Technology (NIST) certified standard reference materials of SRM-1633a (coal fly ash) and SRM-688 (basalt rock) were similarly prepared, as were quality control samples (e.g., standards treated as unknowns) of SRM-278 (obsidian rock) and Ohio Red Clay (a standard developed for in-house applications).

Irradiation and Gamma-Ray Spectroscopy

Neutron activation analysis of ceramics at MURR, which consists of two irradiations and a total of three gamma counts, constitutes a superset of the procedures used at most other NAA laboratories (Glascock 1992; Neff 1992, 2000). As discussed in detail by Glascock (1992), a short irradiation is carried out through the pneumatic tube irradiation system. Samples in the polyvials are sequentially irradiated, two at a time, for five seconds by a neutron flux of 8×10^{13} n cm^{-2} s^{-1} The 720-second count yields gamma spectra containing peaks for nine short-lived elements aluminum (Al), barium (Ba), calcium (Ca), dysprosium (Dy), potassium (K), manganese (Mn), sodium (Na), titanium (Ti), and vanadium (V). The samples are encapsulated in quartz vials and are subjected to a 24–hour irradiation at a neutron flux of 5×10^{13} n cm^{-2} s^{-1}. This long irradiation is analogous to the single irradiation utilized at most other laboratories. After the long irradiation, samples decay for seven days, and then are counted for 1,800 seconds (the "middle count") on a high-resolution germanium detector coupled to an automatic sample changer. The middle count yields determinations of seven medium half-life elements, namely arsenic (As), lanthanum (La), lutetium (Lu), neodymium (Nd), samarium (Sm), uranium (U), and ytterbium (Yb). After an additional three- or four-week decay, a final count of 8,500 seconds is carried out on each sample. The latter measurement yields the following 17 long half-life elements: cerium (Ce), cobalt (Co), chromium (Cr), cesium (Cs), europium (Eu), iron (Fe), hafnium (Hf), nickel (Ni), rubidium (Rb), antimony (Sb), scandium (Sc), strontium (Sr), tantalum (Ta), terbium (Tb), thorium (Th), zinc (Zn), and zirconium (Zr).

Interpreting Chemical Data

The analyses at MURR described previously produced elemental concentration values for 33 elements in most of the analyzed samples. Data for Ni in most samples was below detection limits (as is the norm for most New World ceramic analyses) and was removed from consideration during the statistical analysis. In order to make the data compatible with the Chupadero reference groups, calcium and potassium were also eliminated during these comparisons.

Statistical analysis was subsequently carried out on base-10 logarithms of concentrations on the remaining 30 elements. Use of log concentrations rather than raw data compensates for differences in magnitude between the major elements, such as iron, on one hand and trace elements, such as the rare earth or lanthanide elements (REEs). Transformation to base-10 logarithms also yields a more normal distribution for many trace elements.

The interpretation of compositional data obtained from the analysis of archaeological materials is discussed in detail elsewhere (e.g., Baxter and Buck 2000; Bieber et al. 1976; Bishop and Neff 1989; Glascock 1992; Harbottle 1976; Neff 2000) and will only be summarized here. The main goal of data analysis is to identify distinct homogeneous groups within the analytical database. Based on the provenance postulate of Weigand *et al*. (1977), different chemical groups may be assumed to represent geographically restricted sources. For lithic materials such as obsidian, basalt, and cryptocrystalline silicates (e.g., chert, flint, or jasper), raw material samples are frequently collected from known outcrops or secondary deposits and the compositional data obtained on the samples is used to define the source localities or boundaries. The locations of sources can also be inferred by comparing unknown specimens (i.e., ceramic artifacts) to knowns (i.e., clay samples) or by indirect methods such as the "criterion of abundance" (Bishop *et al*. 1992) or by arguments based on geological and sedimentological characteristics (e.g., Steponaitis *et al*. 1996). The ubiquity of ceramic raw materials usually makes it impossible to sample all potential "sources" intensively enough to create groups of knowns to which unknowns can be compared. Lithic sources tend to be more localized and compositionally homogeneous in the case of obsidian or compositionally heterogeneous as is the case for most cherts.

Compositional groups can be viewed as "centers of mass" in the compositional hyperspace described by the measured elemental data. Groups are characterized by the locations of their centroids and the unique relationships (i.e., correlations) between the elements. Decisions about whether to assign a specimen to a particular compositional group are based on the overall probability that the measured concentrations for the specimen could have been obtained from that group.

Initial hypotheses about source-related subgroups in the compositional data can be derived from non-compositional information (e.g., archaeological context, decorative attributes, etc.) or from application of various pattern-recognition technique to the multivariate chemical data. Some of the pattern recognition techniques that have been used to investigate archaeological data sets are cluster analysis (CA), principal components analysis (PCA), and discriminant analysis (DA). Each of the techniques has its own advantages and disadvantages which may depend upon the types and quantity of data available for interpretation.

The variables (measured elements) in archaeological and geological data sets are often correlated and frequently large in number. This makes handling and interpreting patterns within the data difficult. Therefore, it is often useful to transform the original variables into a smaller set of uncorrelated variables in order to make data interpretation easier. Of the above-mentioned pattern recognition techniques, PCA is a technique that transforms from the data from the original correlated variables into uncorrelated variables most easily.

PCA creates a new set of reference axes arranged in decreasing order of variance subsumed. The individual PCs are linear combinations of the original variables. The data can be displayed on combinations of the new axes, just as they can be displayed on the original elemental concentration axes. PCA can be used in a pure pattern-recognition mode, i.e., to search for subgroups in an undifferentiated data set, or in a more evaluative mode, i.e., to assess the coherence of hypothetical groups suggested by other criteria. Generally, compositional differences between specimens can be expected to be larger for specimens in different groups than for specimens in the same group, and this implies that groups should be detectable as distinct areas of high point density on plots of the first few components.

It is well known that PCA of chemical data is scale dependent (Mardia *et al*. 1979), and analyses tend to be dominated by those elements or isotopes for which the concentrations are relatively large. As a result, standardization methods are common to most statistical packages. A common approach it to transform the data into logarithms (e.g., base 10).

One frequently exploited strength of PCA, discussed by Baxter (1992), Baxter and Buck (2000z), and Neff (1994, 2002), is that it can be applied as a simultaneous R- and Q-mode technique, with both variables (elements) and objects (individual analyzed samples) displayed on the same set of principal component reference axes. A plot using the first two principal components as axes is usually the best possible two-dimensional representation of the correlation or variance-covariance structure within the data set. Small angles between the vectors from the origin to variable coordinates indicate strong positive correlation; angles at 90 degrees indicate no correlation; and angles close to 180 degrees indicate strong negative correlation. Likewise, a plot of sample coordinates on these same axes will be the best two-dimensional representation of Euclidean relations among the samples in log-concentration space (if the PCA was based on the variance-covariance matrix) or standardized log-concentration space (if the PCA was based on the correlation matrix). Displaying both objects and variables on the same plot makes it possible to observe the contributions of specific elements to group separation and to the distinctive shapes of the various groups. Such a plot is commonly referred to as a “biplot” in reference to the simultaneous plotting of objects and variables. The variable inter-relationships inferred from a biplot can be verified directly by inspecting bivariate elemental concentration plots. [Note that a bivariate plot of elemental concentrations is not a biplot.]

Whether a group can be discriminated easily from other groups can be evaluated visually in two dimensions or statistically in multiple dimensions. A metric known as the Mahalanobis distance (or generalized distance) makes it possible to describe the separation between groups or between individual samples and groups on multiple dimensions. The Mahalanobis distance of a specimen from a group centroid (Bieber *et al*. 1976, Bishop and Neff 1989) is defined by:

$$D^2_{y,X} = [y - \overline{X}]^t I_x [y - \overline{X}]$$

where *y* is the 1 x m array of logged elemental concentrations for the specimen of interest, X is the n x m data matrix of logged concentrations for the group to which the point is being compared with $\overline{X}$ being it 1 x m centroid, and I_x is the inverse of the m x m variance-covariance matrix of group *X*. Because Mahalanobis distance takes into account variances and covariances in the multivariate group it is analogous to expressing distance from a univariate mean in standard deviation units. Like standard deviation units, Mahalanobis distances can be converted into probabilities of group membership for individual specimens. For relatively small sample sizes, it is appropriate to base probabilities on Hotelling's T^2, which is the multivariate extension of the univariate Student's t.

When group sizes are small, Mahalanobis distance-based probabilities can fluctuate dramatically depending upon whether or not each specimen is assumed to be a member of the group to which it is being compared. Harbottle (1976) calls this phenomenon "stretchability" in reference to the tendency of an included specimen to stretch the group in the direction of its own location in elemental concentration space. This problem can be circumvented by cross-validation, that is, by removing each specimen from its presumed group before calculating its own probability of membership (Baxter 1994; Leese and Main 1994). This is a conservative approach to group evaluation that may sometimes exclude true group members.

Small sample and group sizes place further constraints on the use of Mahalanobis distance: with more elements than samples, the group variance-covariance matrix is singular thus rendering calculation of I_x (and D^2 itself) impossible. Therefore, the dimensionality of the groups must somehow be reduced. One approach would be to eliminate elements considered irrelevant or redundant. The problem with this approach is that the investigator's preconceptions about which elements should be discriminate may not be valid. It also squanders the main advantage of multielement analysis, namely the capability to measure a large number of elements. An alternative approach is to calculate Mahalanobis distances with the scores on principal components extracted from the variance-covariance or correlation matrix for the complete data set. This approach entails only the assumption, entirely reasonable in light of the above discussion of PCA, that most group-separating differences should be visible on the first several PCs. Unless a data set is extremely complex, containing numerous distinct groups, using enough components to subsume at least 90% of the total variance in the data can be generally assumed to yield Mahalanobis distances that approximate Mahalanobis distances in full elemental concentration space.

Lastly, Mahalanobis distance calculations are also quite useful for handling missing data (Sayre 1975). When many specimens are analyzed for a large number of elements, it is almost certain that a few element concentrations will be missed for some of the specimens. This occurs most frequently when the concentration for an element is near the detection limit. Rather than eliminate the specimen or the element from consideration, it is possible to substitute a missing value by replacing it with a value that minimizes the Mahalanobis distance for the specimen from the group centroid. Thus, those few specimens which are missing a single concentration value can still be used in group calculations.

Results

The samples in this study were statistically compared to existing and preliminary groups using a combination of bivariate plots and Mahalanobis distance comparisons to examine the relationship between the new samples and established compositional groups from the region. Table 1 lists the samples along with ceramic type, group membership, and probably production location.

Table 1: Group membership, probabilities of membership, and probable production location.

ANID	Alt ID	Ceramic Type	Group	(%)	Production Location
TRE001	201-1	Jornada Brown	G72	87	Otero Mesa/Guadalupe Mtns
TRE002	201-2	Jornada Brown	G10	17	Western Hueco Bolson
TRE003	201-3	Jornada Brown	G61	61	Northern Tularosa Region
TRE004	202-1	South Pecos brown	G71	66	Guadalupe Mtns/Salt Flat
TRE005	202-2	South Pecos brown	G71	39	Guadalupe Mtns/Salt Flat
TRE006	461-1	Mimbres (unknown type) Rim	none		?
TRE007	461-2	El Paso Polychrome Rim	G72	6	Otero Mesa/Guadalupe Mtns
TRE008	513-1	Chupadero Black-on-White	Chup 1B	81	Capitan Mtns.
TRE009	523-1	Chupadero Black-on-White	Chup 1C	12	Capitan Mtns.
TRE010	535-1	Jornada Brown Rim	none		?
TRE011	536-1	Chupadero Black-on-White	Chup 1C	10	Capitan Mtns.
TRE012	536-2	Chupadero Black-on-White	Chup 2B	19	Salinas District
TRE013	542-1	El Paso Polychrome	many		El Paso/Jornada Region
TRE014	558-1 Corona	Corrugated	none		?
TRE015	582-1	El Paso Polychrome Rim	G64	61	Northern Tularosa Region
TRE016	657-1 Corona	Corrugated	none		?

Comparison with Chupadero Compositional Groups:

The Chupadero ceramic database is divided into two main groups with many subgroups. Group 1 was likely produced in the Sierra Blanca/Capitan Mountains area, and Group 2 was likely manufactured in the Salinas District. We have not recently reviewed the Chupadero database and thus the interpretation is based on previous analyses of the database. Three of the samples match Group 1 subgroups that are likely produced in the Capitan Mountains and one sample (TRE012) belongs to a Group 2 subgroup and was likely produced in the Salinas District.

Comparison with Jornada and El Paso Compositional Groups

Miller and Ferguson have recently begun a complete reinterpretation of all the non-whitewares from southern New Mexico and the adjacent areas of Texas and Northern Mexico. A preliminary version of this new interpretation was presented at the 2010 Mogollon Conference in Las Cruces, and a more complete version is planned for presentation at the 2011 Society for American Archaeology Meetings in Sacramento. The previous reference groups for the region were not particularly informative as to likely production locations because one main group, El Paso Core, was thought to represent production in the greater El Paso area, and it pulled in most samples analyzed from the entire region. So far the new analysis has isolated dozens of compositional groups that mostly seem to have better isolated the production locations. Please keep in mind that the group assignments and production locations are very preliminary. Miller and Ferguson would like to include these new data presented here into the larger database and hopefully provide an updated interpretation over the coming months. Table 1 provides the current best assessment of group assignments and production locations.

Four of the samples seem distinct from other samples in the MURR dataset. TRE006 is very different from all the other samples, particularly in chromium concentration. It is described as a Mimbres sherd, but there is no match with any of the major Mimbres reference groups that were developed about four years ago by Jeff Speakman. Mr. Speakman is reportedly still working on a much refined interpretation of ceramics from the Mimbres Valley, but as of now this interpretation is not available for use. The two Corona Corrugates samples are also unassigned and they seem to be compositionally distinct from each other, suggesting different production locations or paste recipes. TRE010 is also unassigned, but this may change with further refinements of the database by Miller and Ferguson. TRE013 is a rare sample with high probabilities of membership in several groups in the Miller and Ferguson database. At this point we can argue for production somewhere in the general El Paso region (it has greater than a 99% probability of membership in the old El Paso Core Group). Further database refinements may help to isolate the production location of this sample.

Conclusions

The four Chupadero samples fit well into established reference groups for the type with likely production locations in the Capitan Mountains and Salinas District. While the database reinterpretation efforts of Miller and Ferguson are far from complete, the potential utility of these efforts are evidenced by the proposed production location of eight of the twelve brownware sherds as shown in Table 1. Future work with the Miller and Ferguson Brownware database over the next few months may further improve these interpretations.

Acknowledgments

We acknowledge Dan Salberg for his role in preparing the samples for irradiation.

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Appendix I: LCAS Site Report (Runyan 1971)

CULTURAL MATERIAL

The material listed below is the sum total from the site. No attempt has been made to classify individuals into types for this report. Materials recovered are as follows:

FLINT PIECES: Lithic Chips, labeled. 1958

WORKED PIECES: Lithic chips, worked & labeled.............. 76

MICRO FLAKES: Lithic chips, small flakes................... 399

PROJECTILE POINTS: Lithic.................................. 25 whole
46 broken

SCRAPERS: .... 19 Lithic
1 Bone

KNIVES: Lithic.. 3

GRAVERS: Lithic 1

DRILLS: Lithic..1 broken

SHELL Fragments: Clam 13

BEADS: Shell 1

HAMMERSTONES: Lithic.. 5

MANOS: Lithic & Sandstone 7

BONE: Whole & Fragments 1648

AWLS: Bone.. 2

POTTERY: Sherds 435

POTTERY, some types noted:

> Jornada Brown, El Paso Brown, South Pecos Brown, Roswell Brown, El Paso Polychrome, Ramos Polychrome, Chupadero Black-White, Gila Polychrome and Membres Black-White (Boldface).

The tenative date span of these pottery sherds places the date of the site about 1250 A.D. A detailed study of the pottery will place the date of the site closer to a definite time period (s).

N.

Photo
Ref.

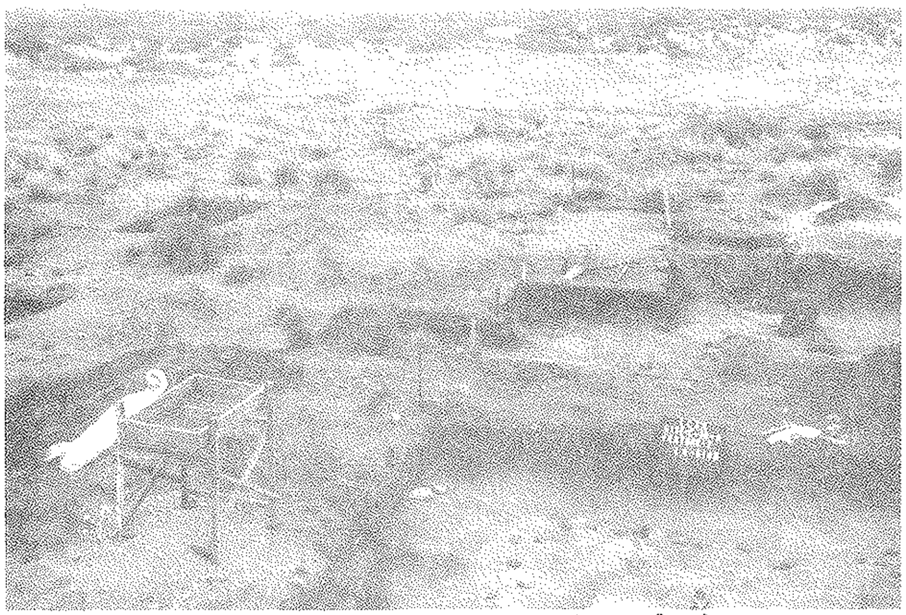

FIGURE 8. General view of a portion of site.
Upper part of Feature 2, and
Feature 1 - center.

FIGURE 9. Bone awl found in square 5S2E, eight
inches below surface.

The clay floor had been badly disturbed by animal burrows, many post holes had been destroyed, making the feature difficult to outline. There were so many post holes out of pattern it is felt that this structure was repaired one or more times by replacing posts, particularly inside.

One of the more important finds on the site, was that of two posts found in place in this room (Refer to figure No. 7). Post No. 1 is about twelve (12) inches long and rotted-off three (3) inches above the clay floor. This post still has the bark attached and is in very good condition. The post extended through the clay pad to the mottled green-white gypsum clay, directly below the pad. It had been set in place with the small end in the pad, and the post had been cut to length by burning off the end. Post No.2 was rotted off at floor clay level, and it was in very bad condition (size 1" x 5½"). Both posts are probably cedar, but definite identification is pending. There were no artifacts or fire hearths found in association with this feature.

POST HOLES:

The post holes in all three features were most difficult to detect, after the midden had been removed from the clay pad. The best proceedure was to let the clay pad dry, then the post holes were quite visible. The post holes ranged in size from one (1) inch to two and one half (2½) inches in diameter and generally extended through the clay pad.

CARBON 14 SAMPLE:

There were two good carbon samples found in Feature No. 2. One was taken and the other was left in place as a reserve. Both were found in situ directly on the clay pad inside the room.

The sample taken was one-half (½) inch in diameter and eighteen (18) inches long. It was located in square 13S3E, ten (10) inches below the surface. There was no apparent root fiber in the charcoal, or any visible organic contamination. The sample was picked-up with a pair of tweezers and placed in aluminum foil.

MIDDEN:

Obviously the dense midden which covers the three "house" features are not directly associated with these features, but represents a later occupation of the site. Figure No. 2 indicates the dense portion of the midden is in the shape of a semi-figure eight, perhaps the north portion of the midden belongs to the features. It will be most difficult to pindown this portion of the midden as belonging to the house features because there were no artifacts (pottery or points) found directly associated with the features.

BURIALS:

There were no burials found at or near this site.

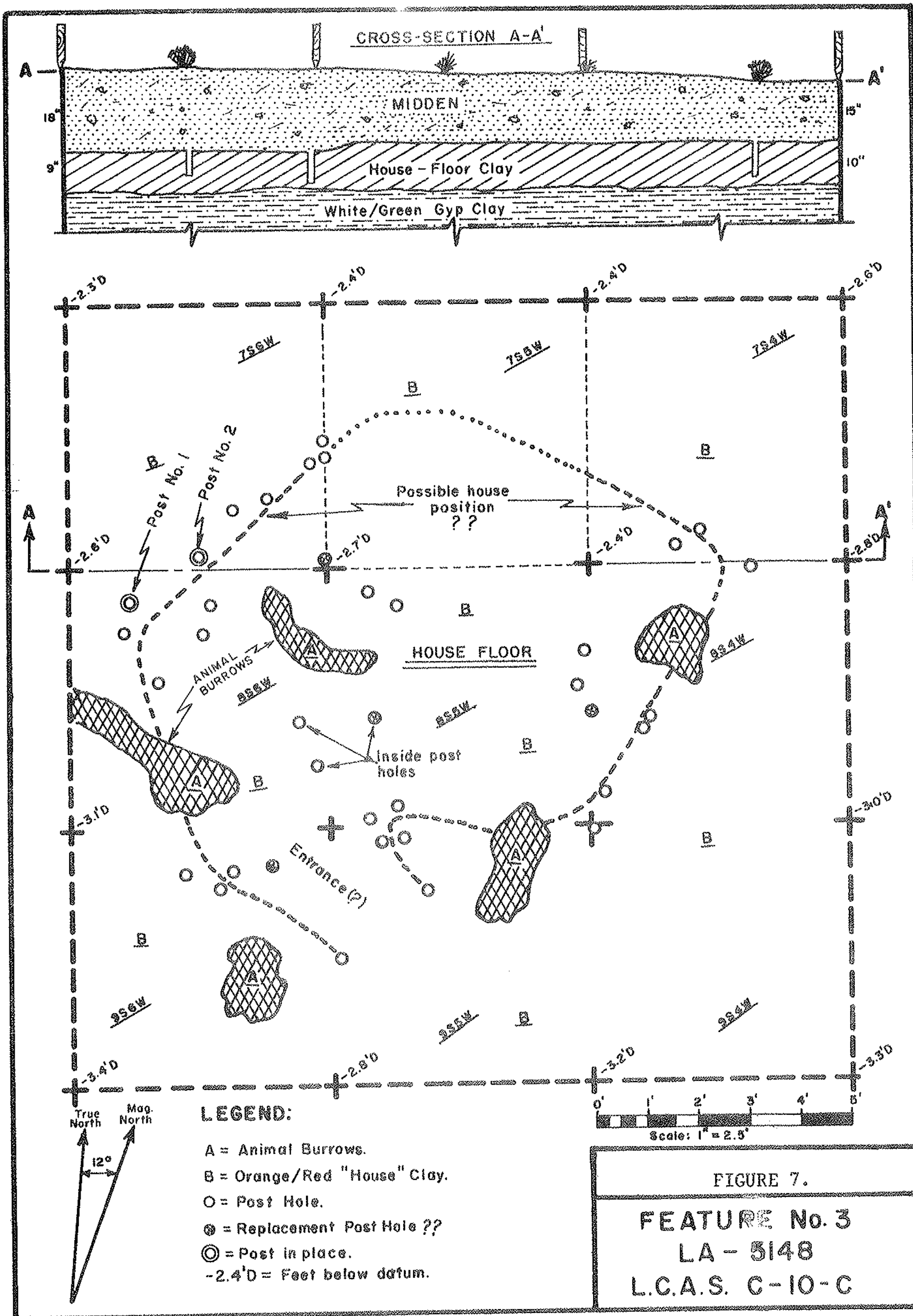

FIGURE 7.

FEATURE No. 3
LA - 5148
L.C.A.S. C-10-C

N.

Photo
Ref.

FIGURE 5. Feature 2, completed. Size 7.6 x 9.5 feet. Note edge of clay pad, left side photo.

S.

Photo
Ref.

FIGURE 6. Close-up of post holes and mano. Note clay hump, upper center photo, possible outside clay plaster.

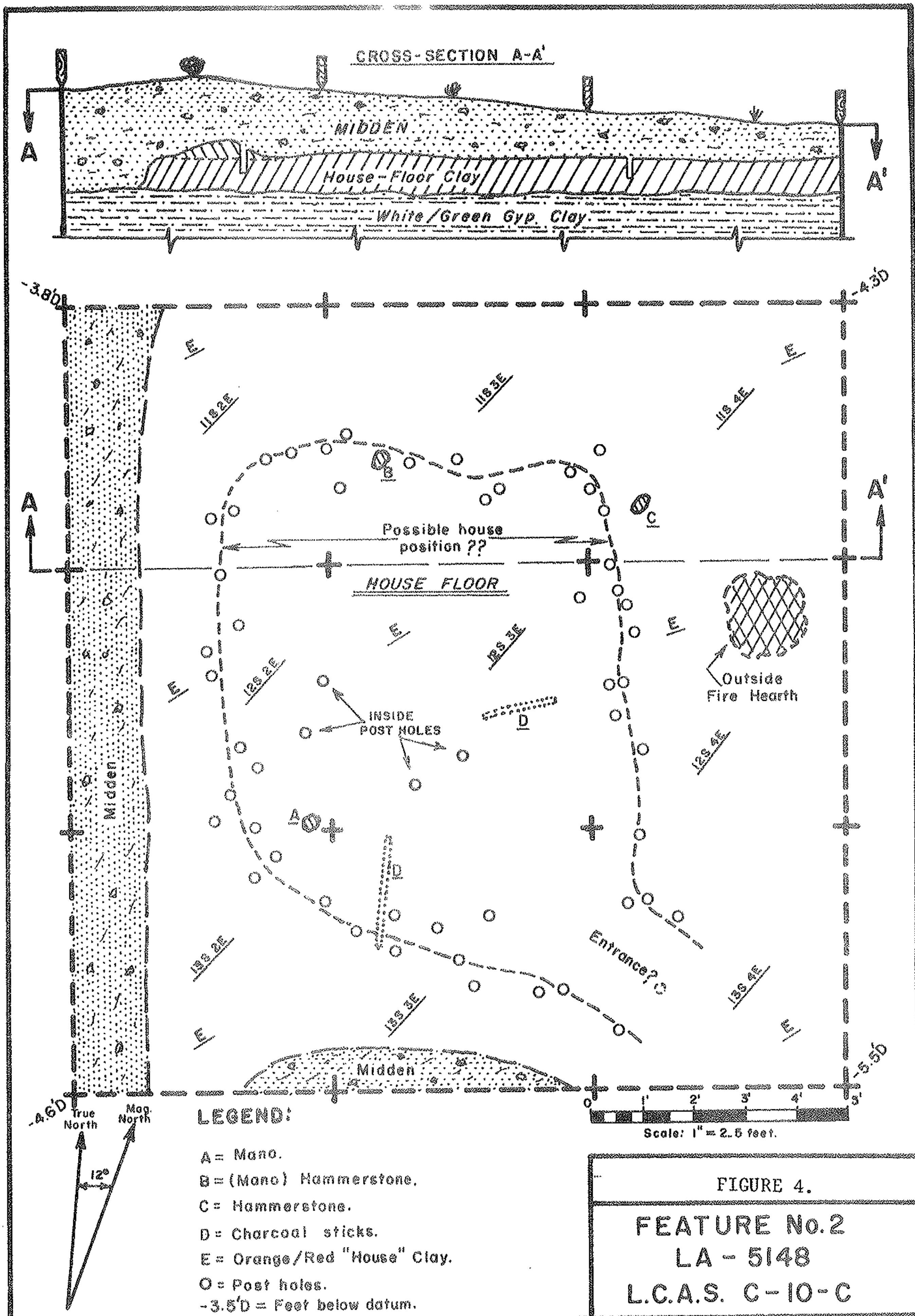

FIGURE 4.

FEATURE No. 2
LA - 5148
L.C.A.S. C-10-C

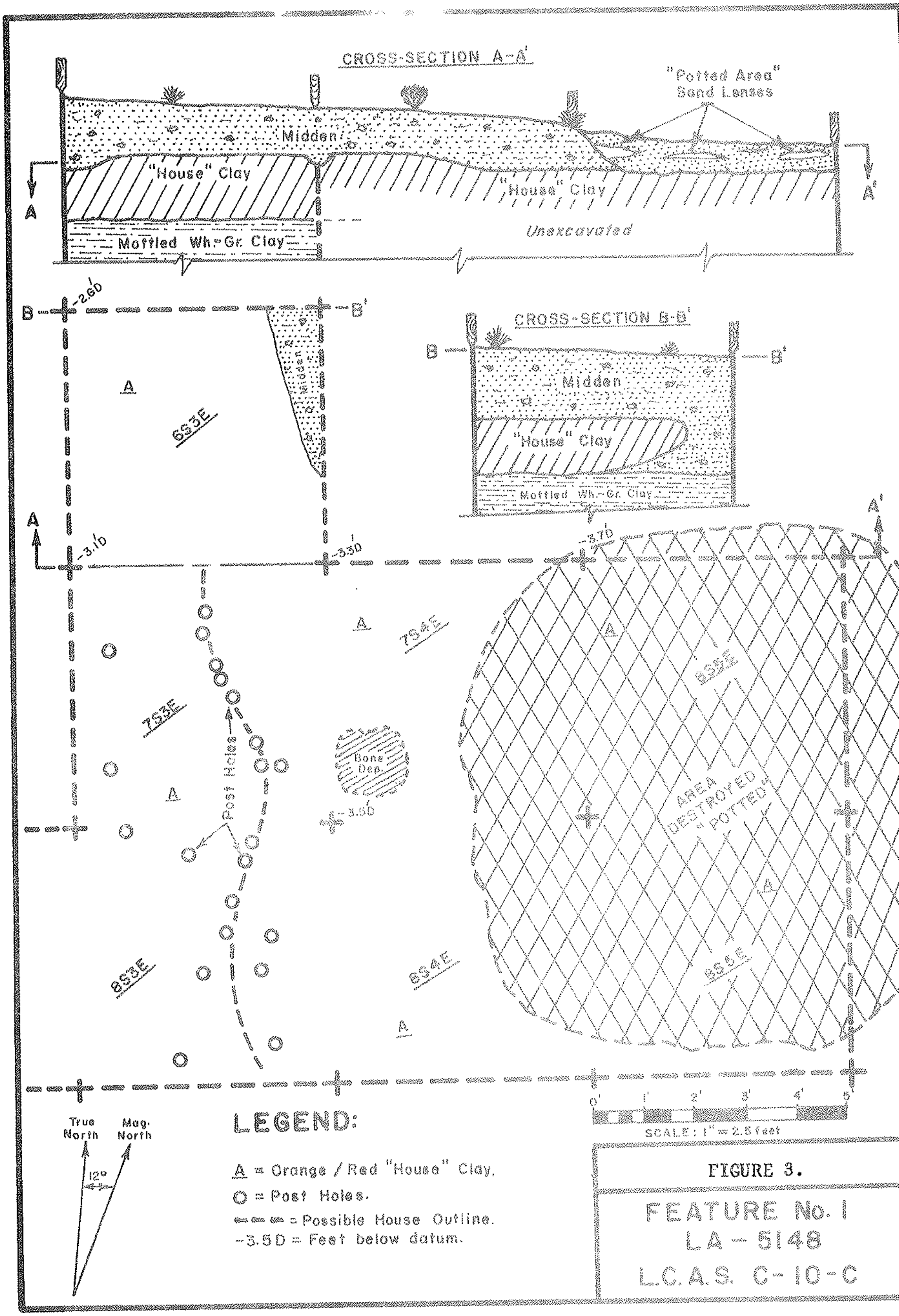

FIGURE 3.

FEATURE No. 1
LA - 5148
L.C.A.S. C-10-C

THE SITE

An important discovery at the site were the house features. These house features are the first of their type to be excavated in this area.

FEATURE No. 1:

This feature has been almost destroyed by vandalism; the remains consists of a series of post holes located on the west side, within an orange-red clay pad which is about nine (9) inches thick. This clay was "brought-in" to make the floor. Neither artifacts nor a fire hearth were found on the floor of this feature. Refer to figure No. 3.

A bone deposit concentrated in the midden above the floor of this feature, in square 7S4E, contained some 150 plus whole and fragmentary bones of several animals. Squares 6S3E, 7S3E, 7S4E and 8S3E contained a total of 675 bones, whole and fragmentary, these consist of about one third of the total bones found over the entire site; all were located in the midden above the feature floor.

FEATURE No. 2:

This was the first definite "house" feature found, and it was in the best condition of the three features (Refer to figures 4, 5 & 6). The feature is semi-rectangular (size 7.6 x 9.5 feet) in shape. The post holes are located in pairs. Some of the post holes are six(6) inches apart while others maybe as much as one (1) foot apart, and they apparently form the outside structure of the house. Two sets of post holes in pairs were found inside and probably acted as roof supports.

No fire hearth was found inside this feature, but an ash lense lying on the orange-red clay pad was found outside (Figure 4), east of the feature.

There is a definite indication that the prepared clay pad acted as both a floor and a support for the wall structure, the wooden posts. The clay pad of this feature averages eight (8) inches thick and rests on a natural mottled greenish-white gypsum clay.

Only three artifacts were found in association with this feature, two hammerstones and a mano; all three were found in direct contact with the clay pad. There was from six (6) to sixteen (16) inches of midden over the clay pad.

Since this feature was in such good shape, a heavy plastic sheet was placed over the clay pad before being backfilled.

FEATURE No. 3:

This feature (Figure No. 7) apparently represents the remains of another semi-rectangular "house" of which the floor consists of typical orange-red clay (size is 8.3 x 10.5 feet).

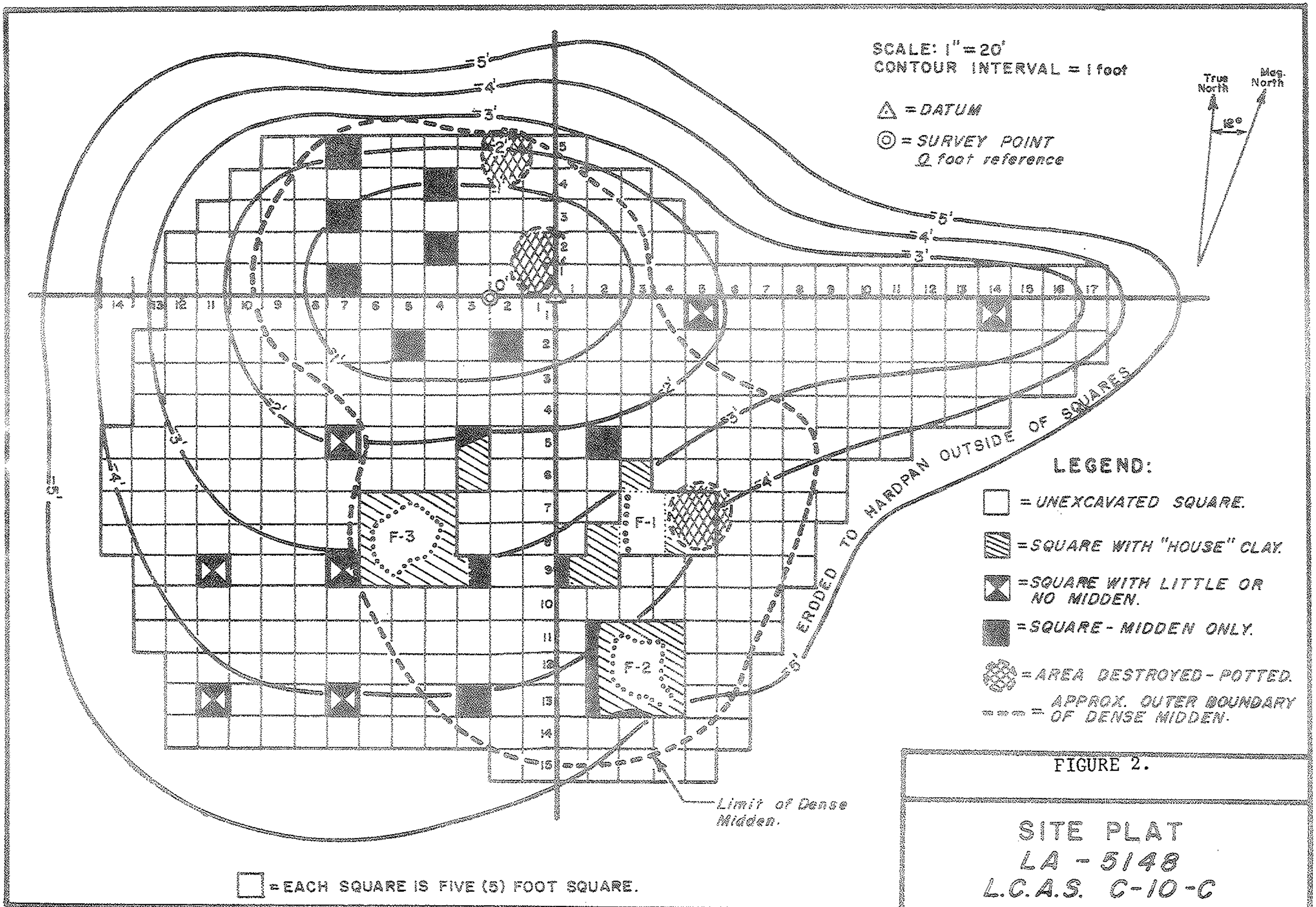

FIGURE 2.

SITE PLAT
LA - 5148
L.C.A.S. C-10-C

SITE PHYSIOGRAPHY

[redacted]

FLORA: The present vegatation in the basin consists of Mesquite, Creasote Bush, Grama Grass, Broom Weed, and some small scattered Cactus. An abundance of Wild Onion and Indian Potato was found in the midden during excavations. The rim above the basin consists of Mesquite, "Shin" oak and Grama Grass.

CLIMATE: The present annual rainfall at the site is about 10 inches. The average mean temperature is 62 degrees with 210 frost free days.

EXCAVATION PROCEEDURES

The site was initially divided into four main areas by surveying-in a north-south and an east-west reference line which intersected at the datum pole. These areas were further divided into five (5) foot, perpendicular grids (Refer to figure No. 2). Each grid (square) was assigned a number according to the number of grids north or south and east or west from the reference lines. This method was used so that a consistant numbering system could be used if the surveyed area of the site needed expanding in any direction.

Since there was no stratification in the midden, each square (grid) was excavated in four (4) inch levels. The midden, from each level, was screened and the cultural material found was sacked as a unit, then each level sack went to the recording crew who labeled and inventoried the material. An inventory sheet was placed in each level sack, then each level sack was placed in a "Square" sack.

The site was excavated in a checker-board pattern (Figure No. 2), so that a good representation of site materials would be obtained, and when any feature was encountered it was excavated as a unit by squares and by four (4) inch levels.

After a square had been excavated through the site cultural material, a 1½ x 1½ x 1 foot test hole was dug in one corner of the square to check the stratigraphy and nature of the underlying soil; this was done on only those squares without features. A crossection was made of one of the walls of each square for correlation purposes. General comments were recorded about each square.

A total of 46 squares including three features were excavated. The squares averaged sixteen (16) inches thick in cultural, midden material.

This page has been removed to protect confidential site location information.

ANTIQUITIES ACT PERMIT

Site LA-5148, (Lea County Archeological Society, Inc., Site C-10-C) "Laguna Plata", is located in the NW/4 of the NE/4 of the NE/4, section 9, Township 20 South, Range 32 East, N.M.P.M., on Federal Bureau of Land Management land, Lea County, New Mexico. Permit No. 70-NM-058 was issued jointly to the Museum of New Mexico and the Lea County Archeological Society, Inc., effective September 15, 1970 to January 31, 1971.

The archeologist in general charge of this site is Mr. George H. Ewing, Associate Director, State Archeologist, Museum of New Mexico, Santa Fe, New Mexico. In actual charge, John W. Runyan, Lea County Archeological Society, Inc., Hobbs, New Mexico.

All requirements of permit No. 70-NM-058 have been complied with, except for the transfer of the site materials to the Museum of New Mexico.

PRELIMINARY REPORT AND STATUS OF MATERIALS FOUND

This report is the "Preliminary Report" of work preformed as required at the termination of excavations of the site (LA-5148) under the Department of the Interior Permit. This report does not include any detailed analysis of the materials found at the site, but an inventory of the materials recovered, some photos, line drawings, and comments on the site and features.

Lab sessions will be conducted to analyze the material and artifacts which will entail many extra hours before all the results are tabulated. The final results will be published by the Lea County Archeological Society, Inc. in bulletin form. On completion of the lab analysis, a complete set of field records, lab records, and site materials will be transfered to the Museum of New Mexico for permanent deposit.

Runyan, John..............Chief Supervisor. Surveying, Excavation,
Recording and Preliminary Report.
Runyan, Julia.............Encharge of Recording. Excavation.
Runyan, Emerson...........Excavation.
Runyan, Pamela............Excavation.
Swafford, Mr. ....Excavation.
Swafford, Mrs. ....Excavation.
Talbot, Fred..............Supervisor. Surveying & Excavation.
Talbot, Alene.............Recording.
Zoda, Gail................Excavation, Recording & Telephone.
Zoda, Louise..............Excavation, Recording & Telephone.

Bulloch, Jerry (BSA-Troop 198)....Excavation.
Randolph, David (BSA-Troop 198)...Excavation.
Allen, Diana (N.M.J.C.)*..........Excavation
Capps, Faye (N.M.J.C.)*...........Excavation.
East, Edward (N.M.J.C.)...........Excavation.
Lund, Phillip (N.M.J.C.)*.........Excavation.
McMahan, Cecily (N.M.J.C.)*.......Excavation.
Painter, Jane (N.MJ.C.)*..........Excavation.
*= New Mexico Junior College students.

ACKNOWLEDGEMENTS

The Lea County Archeological Society, Inc. greatly appreciates the sponsorship of the Museum of New Mexico and Mr. George H. Ewing, Associate Director, and the support of Mr. Albert H. Schroeder of the National Park Service, Santa Fe, New Mexico. Without the help and advice of both Mr. Ewing and Mr. Schroeder it would not have been possible to excavate this site.

We also appreciate the cooperation of Mr. Larry Squires, the rancher who has the land under lease on which the site is located, and Pollution Control, Inc., who has a business lease on "Laguna Plata" proper.

The L.C.A.S. had such excellent response from its members and guests in the archeological work that it is only reasonable and fair that they receive full credit for making this excavation and report a success. Forty-eight individuals have put in a total of 1050 man-hours, this includes the preparation, excavation, and recording of the site materials. Several of the L.C.A.S. members have expended many hours on this project, others few, but we are proud of the effort and time they have extended to date.

Below are listed the people who worked on this site and their functions:

Adams, Doug..............Surveying & Recording.
Adams, Martha............Recording.
Borland, Charles.........Excavation & Recording.
Borland, Nettie..........Recording.
Cooke, Selman............Excavation & Editing.
Creager, Nance...........Supervisor. Photography, Surveying & Excavation.
Creager, Barbara.........Excavation.
Creager, Billy...........Excavation.
Creager, Martha..........Excavation.
Garcia, Jessie (Guest)...Excavation.
Higgins, Winnie..........Recording.
Humphrey, John...........Excavation & Recording.
Hungerford, Layne........Excavation, Recording, Surveying, Telephone, Photography & Signs.
Hungerford, Mary Ann.....Recording & Telephone.
Jones, Dailey............Supervisor. Surveying, Excavation & Recording.
Jones, Irene.............Recording & Signs.
Jorden, Bill.............Excavation & Surveying.
King, John...............Excavation.
Lavash, Don..............Excavation, Recording & Editing.
Lavash, Bobbie...........Excavation & Recording.
Lavash, Linda............Excavation & Recording.
Leslie, Robert...........Excavation & Photography.
Lopez, Ramond............Excavation.
Lopez, Mrs. ....Excavation.
Lopez, Joe...............Excavation.
Lopez, Rosa..............Excavation.
Martinez, Nick (Guest)...Excavation.
Mayer, Earl..............Excavation & Recording.
Mayer, Sandra............Recording.
Odell, Carl..............Excavation.

8100 LALE

LEA COUNTY ARCHEOLOGICAL SOCIETY, INC.

HOBBS, NEW MEXICO

THE LAGUNA PLATA SITE

L.C.A.S. C-10-C

LA-5148

A PRELIMINARY REPORT

Lea County Archeological Society, Inc.

January, 1971

Appendix I: LCAS Site Report (Runyan 1971)

Appendix J: Collections From Early Excavations at Laguna Plata

REPORT ON COLLECTIONS FROM EARLY EXCAVATIONS AT LAGUNA PLATA

Martha Graham, Ph.D.

INTRODUCTION

TRC sought to learn more about previous excavations of the site and to locate collections from the earlier excavations, placing special emphasis on identifying and locating the human remains removed from the site during the excavations, as part of its archaeological research on the Laguna Plata site. Martha Graham (Ethnographic Project Manager, TRC-Albuquerque) conducted these investigations. As previously discussed in this report, the Lea County Archaeological Society (LCAS) conducted excavations at the Laguna Plata Site in 1970-1971. Eastern New Mexico University's (ENMU) Agency of Conservation Archaeology (ACA) excavated the site as part of the Caprock Water Project in 1977. TRC did not locate any additional field notes or other documentation about the Lea County Archaeological Society (LCAS), nor did it succeed in locating any member of LCAS that participated in excavations at the Laguna Plata Site. TRC reviewed the collections and associated documentation from ENMU's excavations, including human remains, currently housed in the ENMU Curation Facility (see Appendix L). TRC also identified and corresponded with several members of ENMU's 1977 excavations, none of whom had information to add to the documentation at ENMU.

TRC has concluded that further efforts to locate and interview former excavators about their participation in the Laguna Plata excavations probably would not yield any more information. TRC also determined that field notes and collections from ENMU's excavations are readily accessible and well organized. The human remains from ENMU's excavations are housed at the ENMU Curational Facility. All skeletal elements reported as excavated in 1977 are present. One discrepancy in the human remains' provenience appears to be a transcription error. ENMU has a relatively small number of photographs, stored separately from the artifacts or fields notes, which were not available when Graham visited ENMU. John Montgomery, Anthropological Museum Director, ENMU, currently is investigating this matter to determine whether additional photographs exist. Following is a brief description of the results of TRC's efforts and conclusions.

BACKGROUND

The LCAS conducted excavations on a portion of the Laguna Plata Site in 1970 and 1971 (LCAS, Inc. 1971). The BLM Carlsbad Field Office currently is in control of the original excavation field notes and the approximately 6000 artifacts from the LCAS excavations. The artifacts include bone fragments, ceramics, chipped stone tools and manufacturing debris, and no human remains.

In 1977 as part of the Caprock Water Project, ENMU conducted excavations at the site, and conducted analysis of materials that LCAS had excavated. The original excavation field notes, human remains, and artifacts are stored in the ENMU Anthropology Department's warehouse. The department's artifact database, which includes basic artifact descriptions, provenience, and storage location was accurate when spot-checked.

METHODS

One of TRC's goals for this project was to assess extant information about excavations at the Laguna Plata Site and determine whether information or artifacts in addition to those identified by the BLM existed. For the LCAS excavations, this assessment focused on trying to locate LCAS members who participated in the Laguna Plata excavations and determine whether additional materials beyond those in the possession of the BLM might exist. For the ENMU excavations, TRC focused on assessing the materials curated at ENMU as well as contacting people who had participated in the Caprock Project.

TRC created a list of individuals that participated in both excavations, and attempted to contact a number of them. In the case of the LCAS crew members, this was done by determining which individuals were likely to have been most involved in the project. These included individuals already known to have a major influence in LCAS and people whose names appeared multiple times in different capacities in documentation. TRC used this assessment to identify individuals who appeared to be most active in LCAS and then sought to locate and contact them through telephone white pages and Google searches, and via an inquiry with Calvin Smith (a founding member of LCAS). In the case of the ENMU excavations, a number of those who excavated or authored sections of the Laguna Plata report are currently recognized members of the archaeological community. TRC contacted several of these individuals, and checked for other names in the SAA membership directory and via Google searches.

TRC also made two trips to ENMU to assess the collections of artifact and human remains and field notes. During the first collection visit, on April 7, 2010, Graham reviewed the human remains and artifacts from the site. She reviewed field notes and other documentation associated with excavations at the Laguna Plata Site and the Caprock Water Project during a subsequent visit on June 25, 2010.

FINDINGS

LCAS Excavations

Calvin Smith, Jr. was the only member of LCAS that TRC succeeding in contacting and interviewing. While Smith was a founding member of LCAS, he explained that he had moved away and did not participate in LCAS's excavations at Laguna Plata, and does not know what has happened to the people who did. Smith suggested contacting John Speth, Museum of Anthropology, University of Michigan, Ann Arbor, Michigan. Dr. Speth had been in contact with Robert "Bus" Leslie before Leslie had died. Responding to Graham's inquiry about LCAS collections, Speth said that he has Leslie's notes and photographs from the Merchant Site, and no others. TRC attempted to locate other individuals via Google searches and telephone White Pages search, but was not successful. TRC considered trying to locate people via classified ads in local papers or other public notices, but deemed these efforts would be relatively unsuccessful.

ENMU Excavations

Graham succeeded in contacting several archaeologists involved in the ENMU's investigation of the Laguna Plata site. None of these individuals had any additional insights into the site or the fieldwork conducted therein, however.

The human remains and artifact collections at ENMU have been re-housed and their location information (both provenience and storage location) computerized relatively recently. The human remains artifacts in the ENMU Curation Facility are stored in a secure warehouse. The human remains are kept separate from the artifacts. The collection database for the facility contains basic information about artifact type and provenience. Graham compared counts of materials in the database and found them to be consistent with bags of materials on the shelves in the storage location identified. Table 1 lists this information. The counts are of bags of materials and not number of artifacts.

Table 1 Laguna Plata artifacts by storage location and bag count of material type.

Box/location	Stone	Animal	Plant	Ceramic	Scientific sample	Human remains	See note
H015					1	17	1
H016					1	6	
480	16	21		62	14		
481	57			43			
482	45			55			
483 64		1	1	3			1
484	79	1					2
485	131						
486	37						
487	62						
488	40						
489	20						
490	40						
491	100						
492	80						
493	18						
494	38						
495	40						
496	42						
497	42						
498	79			1			
499	96			6			
500	96			2			
501	70			7			
502	87			9			
503	26			1			
TOTAL	**1405**	**22**	**3**	**189**	**15**	**33**	

Note: Number of Items in this storage location with same provenience as human remains.

Graham noted three artifacts with the same provenience as the human remains. A soil sample is stored with the human remains and appears to have been taken from the burial context. One piece of bone, in box 483, was identified specifically as “nonhuman.” Two stone artifacts were in Box 482. The label for one said that it was quartzite, “found by feet of burial may or may not be in site [situ?].” The second was chalcedony with a label that said “flake found near radius may or may not have been part of site.” Vierra’s report states that no funerary objects were present. One of the human bones has a different provenience than the rest of the human remains. This appears to have been a transcription error. The error may have occurred as early as the original cataloging of the material, and has been carried forward to date. Nothing in the notes or write up of ENMU’s excavations at Laguna Plata would suggest that more than one burial was excavated from the site.

CONCLUSIONS

TRC identified and attempted to locate participants of the 1970-1971 LCAS and 1977 ENMU excavations at the Laguna Plata site in order to learn more about the excavations. TRC also assessed that state of ENMU's collections and field notes. TRC was unable to locate any living members (or descendants) of LCAS who were part of the excavations. Participants of the ENMU excavations responding to TRC's inquiries were not able to contribute any additional information about the site. Graham's assessment of the collections is that the computerized information accurately reflects storage and provenience information. Therefore, it would be relatively easy to access the collections for additional data description and analysis. The human remains are stored separately from the artifacts, in a secure location. All human remains that ENMU excavated from the Laguna Plata site are accounted for. It is Graham's opinion that the one discrepancy in provenience is likely a transcription error and does not reflect a different burial location. Three artifacts are associated with the human remains but not identified as funerary objects. A soil sample appears to have been taken from the burial context and is stored with the human remains. No photographs from ENMU's collections were reviewed during this project. A small number of photographs have been located, and Dr. Montgomery is attempting to ascertain the existence and location of others.

Graham's findings specific to the BLM's goals are as follows—

1. Graham did not succeed in locating anyone from the original LCAS 1970–1971 excavations at the Laguna Plata site (Table 2). It is unlikely that additional efforts in this regard would be worthwhile.
2. Graham contacted several individuals who had participated in the Caprock project and ENMU's 1977 excavations at the Laguna Plata site. None of these offered insights or additional detail into the site or the fieldwork.
3. The collections from the ACA's Caprock Project are well organized and curated at the ENMU Curation Facility. The collections database appears to be accurate.
4. The human remains that ENMU excavated are in the ENMU Collection Facility. The difference in provenience for one element is likely a transcription error.
5. Although several artifacts are identified as having some association with the human remains, their specific association is not clear. Vierra reported that there were no funerary objects associated with the human remains.
6. No photographs from ENMU's collections were reviewed during this project. A small number of photographs have been located, and Dr. Montgomery is attempting to ascertain the existence and location of others.

Table 2 Persons associated with the LCAS investigations

Individual Name	Project	Role	Comments	Contact?
Alene Talbot	LCAS	Recording		
Barbara Creager	LCAS	Excavation		
Bill Jordan	LCAS	Exavate, Survey		
Billy Creager	LCAS	Excavation	William Creager, Nassau Presby Church?	
Bobbie Lavash	LCAS	Excavation, Recording		
Carl Odell	LCAS Ex	cavation		
Charles Borland	LCAS	Excavate, Record		
Dailey Jones	LCAS	Supervisor, Survey, Excavation, Recording		
David Randolph	LCAS	Excavation	BSA Troop 198	
Diana Allen	LCAS	Excavation	NMJC student	
Don Lavash	LCAS	Excavation, Recording	Former SW Historian for NM State Records Ctr & Archives? (Donald R. Lavash?)	
Doug Adams	LCAS	Survey, Recording		
Earl Mayer	LCAS	Excavation, Recording		
Edward East	LCAS	Excavation	NMJC student	
Emerson Runyan	LCAS	Excavation		
Faye Capps	LCAS	Excavation	NMJC student	
Fred Talbot	LCAS	Supervisor, Survey, Excavation		
Gail Zoda	LCAS	Excavation, Recording.	Deceased.	deceased
Irene Jones	LCAS	Recording, Signs		
Jane Painter	LCAS	Excavation	NMJC student	
Jerry Bulloch	LCAS	Excavation	BSA Troop 198	
Jessie Garcia	LCAS	Excavation	Guest	
Joe Lopez	LCAS	Excavation		
John Humphrey	LCAS	Excavation		
John King	LCAS	Excavation		
John Runyan	LCAS	Chief Supervisor. Survey, Excavation, Recording, Preliminary Report	Deceased. dece	ased
Julia Runyan	LCAS	Recording (in charge), Excavation		
Layne Hungerford	LCAS	Excavation, Recording, Survey, Photography, Signs. deceased; contact wife/daughter?	Deceased. dece	ased
Linda Lavash	LCAS	Excavation, Recording		
Louise Zoda	LCAS	Excavation, Recording		
Martha Adams	LCAS	Recording		
Martha Creager	LCAS	Excavation	Martha Barnes Creager, Odessa, TX?	
Mary Ann Hungerford	LCAS Recor	ding		
Mr. and Mrs. Swafford	LCAS Ex	cavation		

Individual Name	Project	Role	Comments	Contact?
Mrs. Lopez	LCAS	Excavation		
Nance Creager	LCAS	Supervisor, Photography, Survey, Excavation	Deceased. Creager Family Foundation, c/o John A Woodside, 500 W Illinois Ave Ste 300, Midland TX 79701-4337	deceased
Nettie Borland	LCAS	Recording		
Nick Martinez	LCAS	Excavation	Guest	
Pamela Runyan	LCAS	Excavation		
Phillip Lund	LCAS	Excavation	NMJC student	
Ramon Lopez	LCAS	Excavation		
Raymond Lopez	LCAS	Excavation		
Robert Leslie	LCAS	Excavation, Photography	Deceased.	deceased
Rosa Lopez	LCAS	Excavation		
Sandra Mayer	LCAS	Recording		
Selman Cook	LCAS	Excavation, Edit		
Winnie Higgins	LCAS	Recording		
Barbara Penington	Caprock	Archaeological assistant		
Benjamin Gonzales	Caprock	Archaeological assistant		
Bradley Vierra	Caprock	Caprock report	Archaeologist, SRI	Yes
Bruce A. Burns	Caprock	Caprock Report, archaeological assistant, ceramic analysis		
Carol Klager	Caprock	Archaeological assistant		
Charles Haecker	Caprock	Crew chief	Archeaologist, NPS	attempted
Cheryl Wase	Caprock	Crew chief	Deceased.	deceased
Cynthia Irwin-Williams	Caprock	Administered aspects of project	Deceased. dece	ased
David A. Yos	Caprock	Caprock Report, Botany		
Don Hogg	Caprock	Archaeological assistant		
Fred L. Nials	Caprock	Caprock Report, Geology	602-616-4709; fnials@earthlink.net	Yes
Hayward Franklin	Caprock	Ceramic analysis		
J. Loring Haskell	Caprock	Caprock Report		
Jeffrey Nielsen	Caprock	Crew chief		
John Beimly	Caprock	Archaeological assistant, ceramic analysis		
John Doebley	Caprock	Crew chief		
Lawrence Baker	Caprock	Ceramic analysis		
Leland Kilmer	Caprock	Archaeological assistant		
Lynne Arany	Caprock	Caprock Report, archaeological assistant, ceramic analysis		
Michael Jacobs	Caprock	Ceramic analysis		
Pamela Morden	Caprock	Caprock Report, archaeological assistant		
Peter Bullock	Caprock	Archaeological assistant		
Peter McKenna	Caprock	Archaeological assistant	Archaeologist, BIA	Yes
Rodrick McLennen	Caprock	Archaeological assistant	Southwestern New Mexico Archaeological Foundation?	attempted

Individual Name	Project	Role	Comments	Contact?
Roger A. Moore	Caprock	Caprock Report (lithic analysis)		
Sally Kleiner	Caprock	Lithic analysis		
Stephen Lekson	Caprock	Ceramic analysis	Archaeologist, UC Boulder	
Thomas Baker	Caprock	Caprock Report (lithic analysis), archaeological assistant		
William C. Gray	Caprock	Faunal and palynological analyses		
William Davis	Caprock	Archaeological assistant		
Zoe C. Clark	Caprock	Caprock Report	Zoe Johnson?	
John Roney	Caprock	Caprock project	Archaeologist (retired), BLM	Yes

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1977 *Caprock Water System Archaeological Project, Lea County, New Mexico*. Agency of Conservation Archaeology, Eastern New Mexico University, Portales.

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1971 The Laguna Plata Site, L.C.A.S. C-10-C, LA-5148, a Preliminary Report. Lea County Archaeological Society, Hobbs.

Vierra, Bradley J.
1977 Appendix 4: A Burial from Laguna Plata, ENM10017. In *Caprock Water System Archaeological Project, Lea County, New Mexico*, pp. 395-402. Agency of Conservation Archaeology, Eastern New Mexico University, Portales.

Appendix K: Analysis of “Too Small Ceramic Sherds”

The BLM Permian Basin Program
THE LAGUNA PLATA PROJECT's "TOO SMALL" SHERDS
Preliminary Analysis

Regge N. Wiseman
Research Associate
Office of Archaeological Studies
Department of Cultural Affairs
Santa Fe NM

September 2010

Submitted to: **Adriana Romero**
Laboratory Director
TRC Environmental
5400 Suncrest Drive, Suite D1
El Paso TX 79912-5615

Notes

Because of time constraints, I was able to partially analyze only a few of the bags of sherds. I looked through all other bags to get a general idea as to their contents and to note sherds of particular interest. My observations relative to these two levels of examination are presented in separate sections below.

The shorthand for specific pottery types is:

EPB	El Paso Brown; in some cases could be lower body sherds of EPP.
EPP	El Paso Polychrome
IC	indented corrugated
JB	Jornada Brown
JB/SPB	Jornada Brown/South Pecos Brown (JB attributes generally dominate)
SPB	South Pecos Brown
SPB/JB	South Pecos Brown/Jornada Brown (SPB attributes generally dominate)
terracotta	either a well-oxidized plain brown type or an unpainted body sherd of one of the red-on-terracotta types.

Sherd Lots Examined in Some Detail

Sherds were examined under a Bausch & Lomb binocular microscope set at 30 diameters and using a Fiber-lite Model 190 illuminator.

PNUM Bag **6**.	2 JB	
	1 EPB	**made in Sierra Blanca region?**, Lincoln co., NM (?)
Bag **210**.	2 JB/SPB	
	1 JB	
Bag **211**.	3 JB	
Bag **212**.	1 JB/SPB	
	2 unk/uncert brown	**unfamiliar tempers**; both well polished, thin (4-5 mm), plain surfaced; could be same vessel.
Bag **213**.	1 **Salado poly**?	paste and temper okay for series, but paint *appears* to be mineral.
	1 JB	
	2 JB	medium-size temper
	1 JB/SPB	
Bag **214**.	1 SPB/JB	
Bag **216**.	1 SPB/JB	
Bag **217**.	1 JB	medium-size temper
	1 **Alma**?	very finely ground tuff? temper w/ some gold mica flecks
	1 **Alma**	rhyolitic tuff? temper
Bag **218**.	7 **Alma?**	very thin; probably all same vessel.
	2 SPB/JB	
	1 JB	medium-size temper.
	1 white ware	surfaces and edges stained light brown color; not Chupadero.
Bag **219**.	2 SPB/JB	
Bag **220**.	3 SPB/JB	

Bag 221. 1 **Chupadero B/w** jar sherd w/ fine to med sherd temper in white paste.
1 terracotta? gray and other feldspar

Bag 222. 3 **Chupadero B/w** all sherd tempered but all different jars.
1 red-slipped bowl sherd; paste is that of JB w/ med-size temper.
1 plain brown very thin (3 mm).

Bag 223. 1 tiny sherd some sort of post-breakage reddish stain on both surfaces and edges.

Bag 224. 1 SPB/JB

Bag 225. 1 terracotta much surface encrustation; could be **Lincoln B/r** but no paint.
2 JB

Bag 226. 1 **Chupadero B/w** jar w/ sherd temper and partially vitirfied paste.
2 SPB/JB

Bag 227. 1 **Chupadero B/w** jar w/ sherd temper and white paste.
1 JB/SPB
1 **Alma?** tuff? temper.

Bag 228. 1 red-slipped
1 JB/SPB
1 **Alma?** tuff? temper

Bag 229. 1 JB
2 SPB/JB

Bag 230. 2 JB
1 JB/SPB

Bag 231. 1 SPB **prominent green crystalline mineral** on one edge.
1 SPB/JB

Bag 232. 1 SPB/JB

Bag **233**. 1 **Lincoln** B/r — gray feldspar temper; interior surface 5YR 6/4; exterior surface 2.5YR 5/5; Lincoln design style w/ 6.5 mm wide lines.
1 **Lincoln** B/r — gray feldspar temper; interior surface 5YR 6/4; exterior surface covered by number; Three Rivers design style w/ 2.5 mm wide line.
1 JB — profuse fine crystalline temper w/ hematite aggregates; 7.5 mm thick.
1 SPB/JB

Bag **234**. 1 red-slipped brown — ***appears to be but is not*** a White Mtn Red Ware (see under 30x).
2 JB
5 SPB/JB

Bag **236**. 2 **Chupadero B/w** — 1 is a jar sherd w/ large sherd temper; the other is uncertain vessel form w/ smaller sherd temper.
3 IC — Mimbres Corr., Corona Corr., Ochoa Corr., and/or unident/unnamed corr.
1 EPB
1 JB
1 JB — feldspar and mafic temper.
3 SPB
1 SPB? — unusual temper; needs temper ID.
1 plain brown — feldspar and unidentified rock temper.

Bag **238**. 1 **Chupadero B/w** — w/ very fine sherd and rock temper.
1 JB? — small to medium grains of gray felspar temper.
1 SPB
1 SPB? — quartz and off-white feldspar temper; long fragment of a plant that is reminiscent of horsetail (*Equisetum* sp.).
1 sandstone — pottery sherd-like fragment

Bag **239**. 1 JB

Bag **240**. 1 JB
2 JB/SPB

Bag **241**. 1 JB
3 SPB/JB

Bag **242**. 1 JB — **scrape marks on interior surface** that are like those on Chupadero.
2 **McKenzie Brown**

Bag **244**. 2 JB

Bag 245. 1 **Ramos Polychrome, Capulin variety**
1 JB/SPB
1 JB/SPB quartz, feldspar, and lots of mafics.

Bag 247. 1 JB
2 JB/SPB

Bag 248. 1 SPB/JB

Bag 249. 1 **Chupadero B/w** jar sherd w/ sherd temper

Bag 470. 23 EPB
9 SPB
8 JB
4 unk/uncert brown
44 Total

Bag 471. 31 SPB
22 EPB
11 JB
3 JB/SPB.
77 Total

Bag 472. 71 EPB
1 JB
72 Total

Bag 479. 42 JB
2 JB/SPB
44 Total

A very interesting bag illustrating range in temper sizes for Jornada Brown (i.e., can be all fine or all medium, with occasional large grains).

Bag 485. 17 IC — Mimbres Corr., Corona Corr., Ochoa Corr., or unident/unnamed corr.
1 brownware — unIDed temper
18 Total

Bag 491. 1 JB
1 SPB

Bag 492. 1 **McKenzie? Brown** quartz and off-white feldspar with some golden biotite.

Bag **493**. 1 unknown brown — Uncertain temper that could be crushed sherd plus sub-angular and sub-rounded rock grains; surfaces poorly smoothed and spottily polished; surfaces and paste dark gray-brown to black; 4.5 mm thick; ***a candidate for a Plains sherd***.

Bag **494**. 1 unknown brown — Very fine leucocratic rock? In black paste; both surfaces fairly well smoothed, polished, and dark gray brown color; 4 mm..

Bag **495**. 2 JB
1 SPB
1 unknown brown — Fine to medium sub-angular & sub-rounded quartz & feldspar in black paste; surfaces smoothed, polished, & dark gray-brown; 5 mm.

Bag **496**. 1 **Chupadero B/w** — jar sherd; very fine to fine crushed rock and sherd temper.
1 JB — Fine to medium white and very light gray crushed rock in black paste; well-smoothed and burnished surface; exterior light to medium gray-brown with fire cloud; 6 mm thick.
1 JB — Medium white and clearish feldspar, quartz, and some medium to large Sierra Blanca gray feldspar in light to medium brown brown paste; surfaces smoothed and fairly well polished; 6 mm thick.

Bag **497**. 2 **Chupadero B/w** — jar sherds with fine and some mediium sherd temper in a nearly white paste.
1 JB?
3 unk/uncert brown — unIDed temper.

Bag **498**. 2 JB

Bag **499**. 2 SPB/JB

Bag **501**. 1 JB — interior surface appears to be purposefully smudged.

Bag **502**. 1 SPB/JB
1 JB? — very thin sherd but both surfaces well-polished.

Bag **504**. 1 JB
1 JB/SPB
2 EPB-like — medium temper, black paste w/ reddish margins; poorly smoothed but fairly well-polished surfaces.

Bag **507**.	1 EPB-like	Appears to have both EPB temper (white feldspars and plenty of quartz as sub-angular and sub-rounded grains) and Sierra Blanca (NM) gray syenite w/ hornblende; black paste; surfaces medium gray-brown but eroded.(surface finish missing); 6 mm thick.
	1 EPB	Medium brown-gray surfaces; thick (7.0-7.5 mm).
Bag **508**.	2 SPB/JB	
	1 unk/uncert brownware	sparse, small, crystalline rock temper; gray paste.
Bag **511**.	1 SPB?	
Bag **512**.	1 **Chupadero B/w**	mis-fired bowl sherd; fine sherd and crushed rock temper.
	1 SPB/JB	
	1 unk/uncert brown	tiny sherd
Bag **514**.	1 JB	
	1 EPB	fine, relatively sparse temper.
Bag **516**.	2 **Lincoln B/r**	Larger sherd is classic (thick; ext. half of paste is gray, int. half orange; Sierra Blanca gray syenite temper; interior surface 2.5YR 5/4; Lincoln design style).
	1 **Three Rivers R/t**	Design is a triangle on a 2 mm wide line.
	1 **EPPoly**	
	1 EPB??	Crushed off-white crytalline temper; occasional rounded quartz grains; **several grains of medium gray limestone?**; needs petrographic identification; surface characteristics very El Paso-like.
	1 JB or **Alma?**	rhyolitic tuff? temper; needs petrographic ID and comparison.
	1 JB or **Alma?**	rhyolitic tuff? temper w/ some gold biotite and tiny hematite bits; needs petrographic ID and comparison.
	1 SPB	
	1 EPB or **EPPoly**	
Bag **517**.	1 JB	
	1 EPB or **EPPoly**	
Bag **521**.	red-slipped brown	jar sherd; crushed rock w/ plenty of mafics
Bag **525**.	1 **Chupadero B/w**	jar; fine dark sherd and some rock temper in white paste.

Bag 526. JB

Bag 527. 1 **Chupadero B/w** — jar; mostly fine w/ some medium-size sherd and rock in light gray paste.
2 SPB/JB
1 SPB

Bag 529. red-slipped brown — jar sherd; sparse crushed rock w/ mafics.

Bag 530. 1 EPB
1 JB

Bag 531. 1 **Gila Polychrome**
1 JB
1 SPB

Bag 532. 1 **Chupadero B/w** — very fine rock w/ some sherd.
1 **EPP**
3 JB
1 JB/SPB
1 SPB
1 **Gallo / Middle Pecos Micaceous Brown**

Bag 534. 1 **EPPoly**

Bag 537.

8 JB	regular surfaces
1 JB	broad tool-scraped exterior surface
1 JB	scraped interior surface
1 SPB/JB	
1 SPB	
2 EPB?	may have been made in the Sierra Blanca region of Lincoln co. NM.

Bag 538.

25 EPB	
1 JB	medium-size temper
2 SPB	
28 Total	

Bag 539. 4 **EPPoly**

Bag 541. 3 **EPPoly**
1 unk/uncert brown

Bag **544**. 3 EPB

Bag **549**. 3 JB
15 SPB
34 EPB
52 Total

Bag **638**. 1 IC — Mimbres Corr., Corona Corr., Ochoa Corr., and/or unident/unnamed corr.
1 red-slipped brown
1 terracotta — strength of orange color and paste colors suggest painted type.
4 JB and JB/SPB
3 **untempered brown** — untempered but w/ occasional natural sand grains; both surfaces and paste contain many voids from steam pockets(?). **possibly Plains in origin**.
10 Total

Bag **640** 99 SPB
60 JB
4 terracotta
1 IC — Mimbres Corr., Corona Corr., Ochoa Corr., and/or unident/unnamed corr.
9 unk/uncert brown
173 Total

Bag **641**. 33 JB
31 SPB
30 EPB
2 **McKenzie Brown**
13 unk/uncert. brown
109 Total

Bag 642. 19 EPB

Bag **643**. 9 SPB

Bag **644**. 17 IC — Mimbres Corr., Corona Corr., Ochoa Corr., and/or unident/unnamed corr.

Bag **645**. 10 SPB/JB
1 JB

Bag **649**. 12 SPB

Sherd Lots Scanned

Perfunctory characterizations were done by quick pass through with respect to ascertaining the primary types in each bag --- Jornada Brown, South Pecos Brown, and El Paso Brown. Thus, even though a bag is listed as having JB and SPB, an occasional El Paso Brown, McKenzie Brown, Alma Plain, etc. could have escaped notice. In the following listing, numbers of sherds are provided for the large bags but generally not for bags containing less than 10 sherds.

Bag **137**. **Chup** and JB

Bag **138**. JB/SPB

Bag **139**. JB

Bag **140**. SPB

Bag **141**. **Chup**, JB, and SPB — the browns need temper ID

Bag **142**. 1 **Chup** — mostly very fine sherd temper
1 JB
1 unident. brown — burnished surfs, hard, med to dk gray paste w/ straight fracture, dark feldspar temper.

Bag **143**. 1 EPB
1 poss. EPB
1 SPB

Bag **144**. 2 SPB/JB

Bag **145**. EPB
JB

Bag **146**. EPB

Bag **148**. EPB
SPB

Bag **150**. 4 SPB/JB

Bag **151**. 3 SPB

1 JB
1 EPB(?).

Bag 152. JB/SPB

Bag 153. EPB(?) off-white syenite temper, plus black mafics and gold mica

Bag 155. 2 EPB

Bag 156. 1 **Chup**; 3 JB/SPB
4 polished EPB(?) interesting tempers

Bag 157. 1 red-slipped brown
1 EPB or **EPP.**

Bag 158. **Red-on-brown or red-on-terracotta** needs petrographic ID of temper.

Bag 159. Mostly SPB, but also EPB and red-slipped brown.

Bag 160. 2 red-slipped brown sherds that refit.

Bag 161. EPB and small piece of sandstone.

Bag 162. SPB, JB/SPB, and two sherds of very thin (3 mm) **EPP** that refit.

Bag 164. Very thin (3 mm) **EPP**? needs temper check.

Bag 165. SPB/JB.

Bag 166. Red-slipped brown or **EPP** needs temper check.

Bag 167. EPB? **made in Sierra Blanca region?** Needs temper check. Sheen on surfaces and on high points of edges appear to be from the scrub brush.

Bag 168. EPB, JB/SPB, and two JB that refit.

Bag 169. very thin (3.0-3.5 mm) polished **EPP**? needs temper check..

Bag 170. EPB-like Capitan aplite? temper; needs surfaces cleaned.

Bag **171**. terracotta/JB, JB, SPB/JB

Bag **172**. very thin (3.0-3.5 mm) EPB or **EPP** needs temper check.

Bag **173**. SPB very crumbly example

Bag **174**. SPB

Bag **175**. JB/SPB

Bag **176**. EPB, polished EPB; red-on-brown/terracotta jar sherd w/ **scraped interior surface**; painted line 7.5 mm wide, thin paint that has been polished over along with surface. n=4

Bag **200** EPB except for one jar sherd of San Andres R/t (?) with gray feldspar and sherd(?) temper (needs to be confirmed). Is sherd truly San Andres, rather than Chup B/w? n=110

Bag **203** Mostly JB, SPB, and JB/SPB; minor amounts of EPB; several interesting temper types, examples of which have been placed in a separate baglet; includes one sherd of **Gallo Micaceous/ Middle Pecos Micaceous**; also, at least one example tempered with hornblendite. n=268

Bag **204**.	JB and SPB	includes 1 terracotta that may be a **Lincoln B/r**; n=59
Bag **205**.	SPB	crumbly examples; n=33
Bag **206**.	JB and SPB	baglet contains two sherds, one pinched-rim brown and the other red-slipped brown. n=90
Bag **207**.	JB	mostly thick JB (possibly classic variety) n=77
	1 red-slipped brown	
	1 brownware	ash? temper
Bag **208**.	JB and SPB	baglet contains 3 **probable Alma Plain** sherds, 2 of which have brushed interior surfaces and tuff tempers; n=73
Bag **209**.	**Chupadero B/w**	large grains of sherd temper

Bag **461**. **EPPoly**

unlabeled bag- JB, SPB/JB; terracotta

"unknown" bag- 1 SPB; 1 JB; 1 **Lincoln B/r** body sherd; 2 red-slipped brown (1 w/ possible bone fragment in paste); 1 **possible Playas**; 3 sherds **to be checked against** Alma Plain and/or northern Mexican plain ware.

Bag **462**. 4 IC Mimbres Corr., Corona Corr., Ochoa Corr., and/or unident/unnamed corr.; see final section below for information on "pulled" sherds.

Bag **463**. Mostly, if not solely, SPB. n=219

Bag **464**. Roughly one-half SPB, 1/4 JB, and 1/4 EPB. n=93

Bag **465**. Mostly JB w/ some JB/SPB and SPB. n=13

Bag **468**. Mostly SPB w/ some JB, plus 1 terracotta. n=32

Bag **469**. Mostly SPB w/ several EPB and 1 JB. n=15

Bag **480**. About half of sherds are terracotta, red-slipped, or painted. Specific types include, but are not necessarily limited to, red-slipped brown and **Broadline R/t**n=35 See final section (below) for information on "pulled" sherds.

Bag **481**. Appears to be all JB, but with one sherd (in baglet) of **Gallo / Middle Pecos Micaceous Brown** (note black mineral [magnetite?] on sherd surfaces). n=10

Bag **482**. Most sherds are red-slipped or painted. Specific types include, but are not necessarily limited to, red-slipped brown and **Broadline R/t**. n=16 See final section (below) for information on "pulled" sherds.

Bag **483**. Several sherds with similar tempers that appear to be either tuff, rhyolitic tuff, or rhyolite. One of the larger sherds has a uniformly light gray paste with an orange interior surface and a medium gray-brown exterior surface, rendering a cross-section appearance that is reminiscent of a gray-paste Rio Grande Glaze or even a fine-paste White Mountain Redware (*but is neither*). n=9 See final section (below) for information on "pulled" sherds.

Bag **484**. About half of sherds are oxidized, red-slipped, or painted. Some are miss-fired browns & gray-browns as is often the case with these types. Specific types include, but are not necessarily limited to, red-slipped brown, **Three Rivers R/t**, and **Lincoln B/r.** n=68

Bag 486. Appears mostly to be EPB and/or SPB. n=24

Bag 487. Appears mostly to be JB, probably classic variety. Three sherds in separate baglet have interesting tempers, and one has a **scraped interior surface**. n=78

Bag 488. Mostly JB with some SPB and EPB. n=133

Bag 550. 1 terracotta, 7 JB and SPB, 10 EPB.

Bag 552. 2 **brushed sherds w/ SPB and JB/SPB paste** (in baglet); otherwise, a few terracotta and lots of JB and SPB. n=50

Bag 553. Mostly SPB and JB, w/ several EPB, 1 **Lincoln B/r** (no paint), 1 **possibly northern Mexican red-on-brown**, and 8 IC (Mimbres Corr., Corona Corr., Ochoa Corr., and/or unident/unnamed corr.). n=278

** Bag 580. Mostly EPB. n=43

** Bag 581. Mostly SPB and SPB/JB w/ some JB; small bag of EPB; baglet of 2 **JB w/ brushed exterior surfaces**. n=302

** Bag 582. **El Paso Polychrome** (some could be **Bichrome**). n=6

(** **These 3 bags** [most or all sherds in each] would be an excellent trial group for INAA analysis because most of their surfaces are slightly to heavily eroded, making type differentiation dependant upon paste and temper characteristics.).

Bag 636. Mostly, if not all, JB, probably with some SPB. n=69

Bag 637. Mostly, if not all, JB, probably with some SPB. n=72

Bag 638. See first section on analyzed sherds.

Bag 639. All JB (and SPB?) except 1 EPB. n=33

Bag 646. **Gallo / Middle Pecos Micaceous Brown**; gold biotite and other mafic minerals (magnetite? and hornblende?) in a quartz and white feldspar matrix. Intact surfaces smoothed and not particularly micaceous in appearance to the unaided eye. n=11

Bag 647. 11 IC Mimbres Corr., Corona Corr., Ochoa Corr., and/or unident/unnamed corr.

Bag **648**. Primarily EPB and SPB. n=54

Bag **649**. SPB See first section on analyzed sherds.

Bag **650**. Mostly JB with varied tempers but mostly Capitan aplite; mostly thick, with range of 6.5 to 8.5 mm; 1 sherd of **JB w/ rhyolite-looking white aphanitic material**; also, 4 sherds of SPB and 1 of **Gallo / Middle Pecos Micaceous Brown**. n=38

Bag **651**. Mostly EPB, **EPPoly**, & poss. **EPBichrome**, plus a few extras (JB, SPB, other). n=56

Bag **652**. Mostly JB, with a rare sherd of SPB. n=132

Bag **653**. Mostly JB, probably classic variant. n=64

Bag **654**. Mostly JB w/ some SPB. n=266

Bag **655**. All SPB and JB? except for,
1 red-slipped or painted terracotta
1 possible **misfired Lincoln B/r**. n=106

Bag **656**. Mostly EPB (including 1 **micaceous EPB**), w/ some SPB and JB. n=24

Bag **657**. 7 IC Mimbres Corr., Corona Corr., Ochoa Corr., and/or unident/unnamed corr.

Bag **658**. Mostly EPB (2 w/ bizarre tempers) w/ some JB and SPB. n=19

Bag **659**. All JB and SPB except for 1 EPB. n=60

Bag **660**. Mostly SPB w/ some JB; one JB sherd w/ **brushed exterior surface**. n=238

Bag **661**. Mostly, if not solely, EPB. n=64

Bag **662**. Mostly Jornada series (SPB, SPB/JB, JB) with at least 1 EPB and **several sherds with one scraped surface but different tempers**. n=47

Bags of "Pulled Sherds"
That Were Hand-Delivered at the Concordance Workshop
on May 26, 2010

Bag **462**. 11 IC Mimbres Corr., Corona Corr., Ochoa Corr., and/or unident/unnamed corr.

Bag **480**.
1 **San Andres R/t** sherd 4
1 **Broadline R/t** sherd 3
2 red-slipped brown sherds 1 and 2

Bag **482**.
2 **Mogollon? R/b** sherds 1 and 2; tuff temper.
1 Mogollon R/b or San Andres R/t sherd 3, jar sherd with brushed interior surface; tuff temper.
1 red-slipped brown sherd 4; either from Sierra Blanca (NM) or *possibly* Saliz variety of San Francisco Red; tuff? temper.

Bag **483**. 3 **Alma Plain** at least two types of tuff temper

Appendix L: Report on ENMU Collections

ENMU EXCAVATIONS AT LAGUNA PLATA
ARCHIVAL DOCUMENTATION

About this table: As part of TRC's contract with the BLM (TRC contract 174673), on June 25, 2010, Dr. Martha Graham visited ENMU to review archival documentation regarding excavations that the Eastern New Mexico University's Agency of Conservation Archaeology conducted at the Laguna Plata site (LA 5148; aka ENMU10017 and LCAS C-10-C). Documentation consisted of nine folders, mostly labeled, and some with a subfolder or other divider inside. The following table consists of Dr. Graham's notes on the folder and subfolder names, and a general description of contents of each file. The documentation that Dr. Graham reviewed did not include photographs. In response to Dr. Graham's subsequent inquiry about photographs, Dr. Montgomery has stated that the ACA should have photographs, but as of August 2010, he had not been able to locate any.

Folder name	Subfolder	General Description
Laguna Plata	n/a	Loose: note 9/23/76 from Neal D. King to Dr. Haskell re "distances" and points (N & E from the section corner)
	Laguna Plata 77-001 ENM 10017-37 1975-76	Catalogued provenience information: "Cataloged Oct. 1980" – accession "cards" w/ vertical and horizontal control, contents, general comments; 3 per page; sheets double-sided. Pages in file are not sequential; unknown if all pages present. Following is the information for each of the three accession records per page: Page / Accession No. [increments of 1]; Site/IM/IA [select one]; No. / Project No.; Project Name / Recorder; Date; Box No. / Datum [left blank]; Vertical control / Horizontal control / No. of Pieces; Contents / / General Comments / / /
	Laguna Plata 77-001 ENM 10017-37 1975-76 [? Illegible] Burial	Records for burial. Some indicate fragments not preserved; one or two indicate fragments/soil was preserved. Accession "cards;" first page at top: "Burial – cataloged Nov – 1-12, 1980. Begins w/ "Page 106 / Accession No. 00800, Site ... No. ENM 10017 / Project No. 77-002 / Project Name: Laguna Plata / Recorder CH / Date 2/75; Box No. 009 / Datum [blank]; Vertical control: feature #101 / Horizontal control: 250 E/ 350 N Burial 001 / No. of Pieces [blank]; Contents: Cranium / / General comments: Bagged fragments not preserved." 00801 12 pcs, thoracic vertebrea [sic]; bagged fragments not preserved." 00802 No. of pieces: 3; Contents: Cervical vertebrae" Several other accession nos. have that bagged bones/fragments not preserved. 00807 – Date 2/77; contents left femur, general comments: Not preserved [mg: the whole femur?] 00813 – tibia, right – General comments: Notes squatting facet preserved. 2 soil and bone fragment bags. 00820 – right femur – General comments: Soil & bone fragments bagged. Others prior to and below this might say something about fragments not being preserved. Page 116, accession number 00832 – Right Ulna ... General Comments: Cataloged 11-12-80 / End

Folder name	Subfolder	General Description
		Burial”
	[no separator, but after burial]	Catalogued provenience information As above. Cataloging in November 1980, generally.
	Subfolder: Laguna Plata 77-001 ENM 10017-37 1976-76 Pt. 2	Catalogued provenience information First accession number Page 41 / accession number 00309 ... Date 10/23/77 ... flotation sample feature ... Second accession number: 00509, Project No. 77002; Project Name Laguna Plata / Recorder: TR; Date 12/7/75; Box No. 00057 / Datum [blank]; vertical control: [blank] / Horizontal Control 190-200 E/ 300-310 N. / No. of Pieces: 6; Contents: Carlsbad Brown / General Comments: Ceramic, Bleier // Remaining accession numbers seem to be from “Project No. ENM 10017.” Sabrina’s response to my pointing out the different project number was “huh,” and that seems to be as far as we can take it. Mg: Actually, it appears that ENM 10017 and 77002 are interchangeable for Laguna Plata – confirm??
	n/a Loos	e sheets: "Site LA 5178 Inventory; lists of contents by box of objects w/ provenience. Sherd types listed and counted (sometimes body/rim specified; sometimes type unidentified)
LP 77.1 Laguna Plata **(2 of 4)**	LP 77.1 Laguna Plata Ceramic Inventory Forms	Inventory forms: Ceramic Inventory Forms – P0001—P0160 w/ horizontal info and various vertical; locations: unspecified; test area 3 (Ridge site location); test area 5; midden site location; test area 2; dune site location; test area 6; transect 150-160N; transect 300-310N; extraneous grids; - Location: Area E, P0001-P0006, horizontal prove E-“#”; vertical: surface - Location: Area Z, P0007, horizontal Z-19; vertical surface - Location: Area A, P0008-9, H: A-14, A-3; V: surface - Location: No area designations, P0010 H: 13; V: surface - Location: No area designations, P0011 H: -8; V: surface - Location: No area designations, P0012 H: -4; V: surface - Location: No area designations, P0013 H: -20; V: surface - Location: Area A, P0014-P0017 H: A-43, -11, -19, -5; V: surface - Location: Area B, P0018-P0025 H: B-1, -20, -15, -38, -51, -4, -48, -32,k -34; V: surface

Folder name	Subfolder	General Description
		- Location: Area Z, P0027-29 H: Z-12, -4, -11; V: surface
	LP 77.1 Laguna Plata Lithic Analysis Forms: ENM 10018-10032	Analysis sheets: “Lithic Analysis: Rough Sort Form” (approximately .75” of forms)
Unnamed	n/a	Loose: map showing grids, localities 1 and 2, features 1 and 2,and burial.2 maps showing contours, topography, and grid units
	Transect 0-10S/30-440E	Transect maps showing grid units, artifacts, features, and topographical details
	Transect 150-160N/30-510E	Transect maps showing grid units, artifacts, features, and topographical details
	Transect 0-450N/260-270E	Transect maps showing grid units, artifacts, features, and topographical details
	Test area #1	Maps showing test area squares excavated; LCAS grid system relative to ENMU grid; LCAS intrusive material excavated by ENMU; profile drawings; rodent disturbance
	Test area #2	Maps showing test area squares excavated; profile drawings
	Test area #3	Maps showing test area squares excavated; site comments; mortar holes in SS outcroppings; ref to 00 Datum; profile drawings One sheet states “00 datum is 5.83 meters below Nr. 9 (3515 ft) SE ¼ Sec. Ridge side” and is on a drawing with “mortar holes in sandstone outcroping” [sic] w/ grids 351E, 20S to 351E, 17S and 352E, 20 S to 352E, 17S
	Test area #4	Maps showing test area squares excavated; profile drawings
	Test area #5	Profile drawing
	Photo log and sample inventories	Lists of provenience info for samples of pollen, bone & shell, flotation, vegetal remains, c-14 (3 pp); "Reconnaissance-Excavation Photographic Record" (2 pp)
	unnamed	Maps from test trenches (project/site not given) and from the "national potash pipeline" (project/site not given, project/site ENM 10025 and 10029)

Folder name	Subfolder	General Description
LP 77.1 Laguna Plata **Papers, Miscellaneous**	n/a Conte	nts: 1. 8.5 x 11 page of larger map showing Eddy/Lea County boundary, R. 29-32E and 30-33 E, and sites (?) in the Maroon Cliffs area. 2. BLM Antiquities Site Inventory by LCAIG [Lea County Archeological Inventory Group] R. Leslie – Site AR-30-6-97, Mortars (in upper R corner: E41 / Class C). "E41" apparently is the LCAS site number. 3. BLM Antiquities Site Inventory by LCAIG R. Leslie – Site AR-30-6-94, Rooms? Campsite (in upper R corner: E36 / Class A). "E36" apparently is the LCAS site number. 4. "Mitigation Recommendations for Mississippi Chemical: The Pipeline Survey." On second page, category "4) Exist both within and without the boundaries of the right-of-way, and are extremely large, both in area covered and in amount of material present (enough material is available to actually sample, rather than totally collect). <u>Identification:</u> ENM 10017; <u>Owner</u>: BLM; <u>Recommend</u>: We would like to mitigate by moving the pipeline; however, in lieu of moving the line, we will sample the portion of this site that comes into the right-of-way, and for a distance of 250 meters beyond the right-of-way since materials in this area are readily visible and will probably continue to wash onto the right-of-way; sample will be by transects (8(, four will be perpendicular to the right-of-way, four will parallel the right-of-way and be perpendicular to the other four; each transect will be 250 meters long, 5 meters wide and spaced at 60 meter intervals to one another; this will give us roughly a 15% areal sample of this portion of the site. <u>Man hours</u>: 350. (also on this pg, ENM 10031 and 10021). 5. BLM Antiquities Site Inventory by LCAIG R. Leslie – Site AR-30-6-98, Campsite (in upper R corner: E42 / Class OB). "E42" apparently is the LCAS site number. 6. "Archaeological Survey Report On State Land On The Proposed Caprock Water System Pipeline Right-Of-Way, In Southeastern New Mexico," prepared by John F. Doebley, February 3, 1975. (John Roney and John Doebley co-PIs on this); does not include ENM 10017 (Laguna Plata). 7. misc. maps showing grids, and some also showing localities 1 and 2, and features 1 and 2 8. Handwritten notes on "Isolated artifacts, Mississippi Potash Caprock Water System Pipeline and Plant Site" Roney and Doebley, 12/20/74 9. Notes and agenda for Southwest Federation of Archaeological Societies 13th annual symposium, La Mesa, TX, April 1-3, 1977. 10. "Collection and Test Excavation, ENM 10017 and ENM 10018" by Jeffrey Nielsen. 11. "An Overview of the Archeology of the Hobbs-Carlsbad Area, Southeastern New Mexico," prepared by John Roney, May 15, 1975. (brief mention of ENM 10017) 12. Report by John Roney of a March 9, 1975, trip with a team of BLM personnel (Ann Loose, Archaeologist, 2 soil scientists, 1 wildlife specialist, 1 fish specialist, and 1 recreation specialist),

Folder name	Subfolder	General Description
		and amateur [sic] archaeologist Mr. Hicks, "doing a preliminary evaluation of the potential environmental impact of a proposed Mississippi Potash Company potash plant). (brief mention of ENM 10017)
LP 77.1 Laguna Plata **Preliminary Reports, Surveys**	n/a Conte	nts: 1. "Mississippi Potash Inc.: Caprock Water System Preliminary Report," January 21, 1975, John Roney. Description of ENMU as a unique site, along with recommendations 2. BLM Antiquities Site Inventory by LCAIG R. Leslie – Site AR-30-6-113, Midden, Campsite (Rooms?), with comments re Runyan (1972)'s assessment by RL. "Class 'B' Preserve for Excavation" 3. "An Archaeological Survey of the Proposed Caprock Watersystem Pipeline Right-of-Way in Southeastern New Mexico," Prepared by John Doebley, January 29, 1975. 23 pp. ENM 10017 on pp 6-7. 4. "Mitigation Recommendations for Mississippi Chemical the Pipeline Survey. February 12, 1975. R. Adams. Category "(4) exist both within and without the boundaries of the right-of-way, and are extremely large, both in area covered and in amount of material present (enough material is available to actually sample, rather than totally collect). ENM 10017, Owner: BLM, Recommended: we would like to mitigate by moving the pipeline; however, in lieu of moving the line, we wills ample the portion of this site that comes into the right-of-way, and for a distance of 250 meters beyond the right-of-way ... 5. "An Archeological Survey of a Proposed Potash Refinery Site in Southeastern New Mexico, prepared by John Roney, Feb 1, 1975..
LP 77.1 Notes (on main part of folder)	ENMU 10017 Feature 1 -- Faunal Remains ENMU-ACA Archaeological Field Specimen Inventory Record	A manila envelope, not a file folder. Punch cards and faunal analysis forms for Feature 3 [not Feature 1]. Approximately 75 pp of "Lithic Analysis: Rough Sort Forms, w/ date stamps of December 16 and 17, 1976
	n/a	A notebook (unbound) Contents: 1. Begins: "The following are all notes on excavation and collection at ENM10017 taken by the field crews under the direction of J. Nielson and J. Doebley. In addition to these notes, there is a book of maps drawn by the field crew under Doebley's direction and a master map done by J. Nielson. Not: All (1 m^2) grids are designated by the point of their NE corner ... "

Folder name	Subfolder	General Description
		2. *Jeff Nielson Notes* begins: Contents: Jeff Nielson's notes include. - Notes on collection in baseline transect - Notes on his field procedures - Notes on photographs he took - Notes on collection of transect 300-310N/30-420E - Notes on surveying in the transects perpendicular to the baseline - Notes on TT #1 and #2 3. *Baseline Collection* 4. *Transect 300-210N/30-420E* 5. *Transect 0-10S/30-440E* 6. *Transect 150-160N/30-510E* 7. *Transect 0-300N/260-270E* 8. *Test Area #1* 9. *Test Area #2* 10. *Test Area #3* 11. *Test Areas 4 & 5, Test Trenches 1 & 2*
LP 77.1 Laguna Plata **Lithic Analysis Forms: ENM 10017**	n/a	Loose analysis sheets (approximately 1.5") ("Lithic Analysis: Rough Sort Form")
LP 77.1 Laguna Plata **(3 of 4)**	LP 77.1 Laguna Plata Ceramic Analysis Forms	"Ceramic Analysis: Rough Sort Form"); most .25" from ENM 10017; on batch of "ACA Other Sites Counts" from ENM 10026, 32, 31, 21, 20
LP 77.1 Laguna Plata Correspondence	n/a	Correspondence dating from 12/10/74 to 9/30/76 and ranging from Antiquities Permit to contract between Mississippi Chemical Corporation and ACA, ENMU. Includes comments on reports, meetings, and survey tasks.