ABSTRACT

Title of Thesis: An Investigation of Maize at Four Sites (LA 20241, LA 38597, LA 112766, and LA 131202) in Eddy County, New Mexico

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A topic of interest for many New Mexico archaeologists is the introduction and domestication of maize in the Southwest. This investigation adds to the archaeological record of when and to what extent maize was integrated into the subsistence of southeastern New Mexico prehistoric groups. Currently, the accepted date range for the introduction of maize in southeast New Mexico is 500–200 BC (Vierra 2020).

Preliminary results of this investigation indicate the presence of maize in the Permian Basin of southeastern New Mexico dating to 2501 +/-125 calibrated (cal) BC; 1000 years prior to the earliest maize site recorded in the archaeological record for the area. The significance of this early date is twofold 1) the Middle Archaic date in comparison to other old maize sites in the area; and 2) the Middle Archaic date challenges the currently accepted migration patterns of maize into southeastern New Mexico. Dr. Jonathan Mabry's 2008 study suggest that maize was introduced no later than 2100 BC in the southwest; however, Mabry states that maize use did not become common in the North American southwest until around 1400 BC (Mabry 2008).

This investigation focuses on a case study of four sites, LA 20241, LA 38597, LA 112766, and LA 131202, in what is now known as Eddy County within the Permian Basin of southeastern New Mexico. I chose these sites because of my direct involvement in the data recovery field investigation and curation. I spent several weeks directing the excavation at Sites LA 112766 and LA 131202. and served as the laboratory manager for processing the artifact collections and flotation samples for all four sites. Evidence recovered from these four archaeological sites in southeast New Mexico, specifically Eddy County, suggest that maize use was low through the Archaic period and did not increase until AD 700–850 (Diehl 1996, Miller 2016, Railey 2016). This thesis demonstrates that maize was present much earlier in the archaeological record than previously reported for southeastern New Mexico.

The analysis of macrobotanical, phytolith, and starch remains, and ceramics, and radiocarbon dates from cultural features at Sites LA 20241, LA 38597, LA 112766 and LA 131202 were examined to answer the question: when and to what extent was maize integrated into the subsistence of southeastern New Mexico prehistoric groups? A radiocarbon date from Feature 5, at Site LA 112766, indicates evidence of maize as early as 2501 +/-125 calibrated (cal) BC. Additionally, radiocarbon dates identified six Late Archaic features and thirteen Early Formative features that contained maize residue collectively from Sites LA 20241, LA 38597, LA 112766, and LA 131202. Lastly, Site LA 20241 had a single Late Formative feature that yielded maize residue. This thesis will focus on the signature of maize in the archaeological record of Archaic and Formative groups of southeastern New Mexico.

AN INVESTIGATION OF MAIZE AT FOUR SITES
(LA 38597, LA 20241, LA 112766, and LA 131202)
IN EDDY COUNTY, NEW MEXICO.

By:

Suzan Granados

Thesis submitted to the Faculty of the Graduate School of the
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Chapter 1 – Introduction

Maize is a tall annual cereal grass originally domesticated in Mexico and widely grown for its large, elongated ears of starchy seeds (Santillian, et al. 2019). For over a millennium, maize was a staple of many southwestern cultures. As time progressed, maize migrated out of Mexico and into the southwestern region of North America (Mathiowetz 2022). Previous research on early maize indicates that domesticates were a primary component of prehistoric subsistence as early as the Late Archaic period from AD 200-AD 550 (Diehl 1996:113). As a New Mexico archaeologist, I ponder how and when maize was introduced to prehistoric groups living in the Permian Basin of southeastern New Mexico. This investigation adds to the archaeological record of when and to what extent maize was integrated into the subsistence of southeastern New Mexico prehistoric groups. This thesis proposes that maize was present during the Middle Archaic period (3000-1800 BC) in southeast New Mexico and integrated into the subsistence economy of foraging groups. Starch, radiocarbon dating, and geomorphological results of this investigation indicate the presence of maize in the Permian Basin of southeastern New Mexico to 2501 +/-125 calibrated (cal) BC; 1000 years prior to the earliest maize site recorded in the archaeological record of the area. These findings are significant because they challenge the currently accepted migration patterns of maize into southeastern New Mexico.

This archaeological investigation is an examination of the cultural material record recovered from Sites LA 20241, LA 38597, LA 112766, and LA 131202 in Eddy County, New Mexico (Figure 1). The general research questions of this investigation focus on subjects related to chronology and paleoenvironment, subsistence strategies such as the size of the foraging and gathering range, mobility and; lithic and ceramic manufacturing and technology. The same data sets were used to assist in answering the thesis question; when, and to what extent was maize integrated into the subsistence of prehistoric groups of the Permian Basin of southeastern New Mexico.

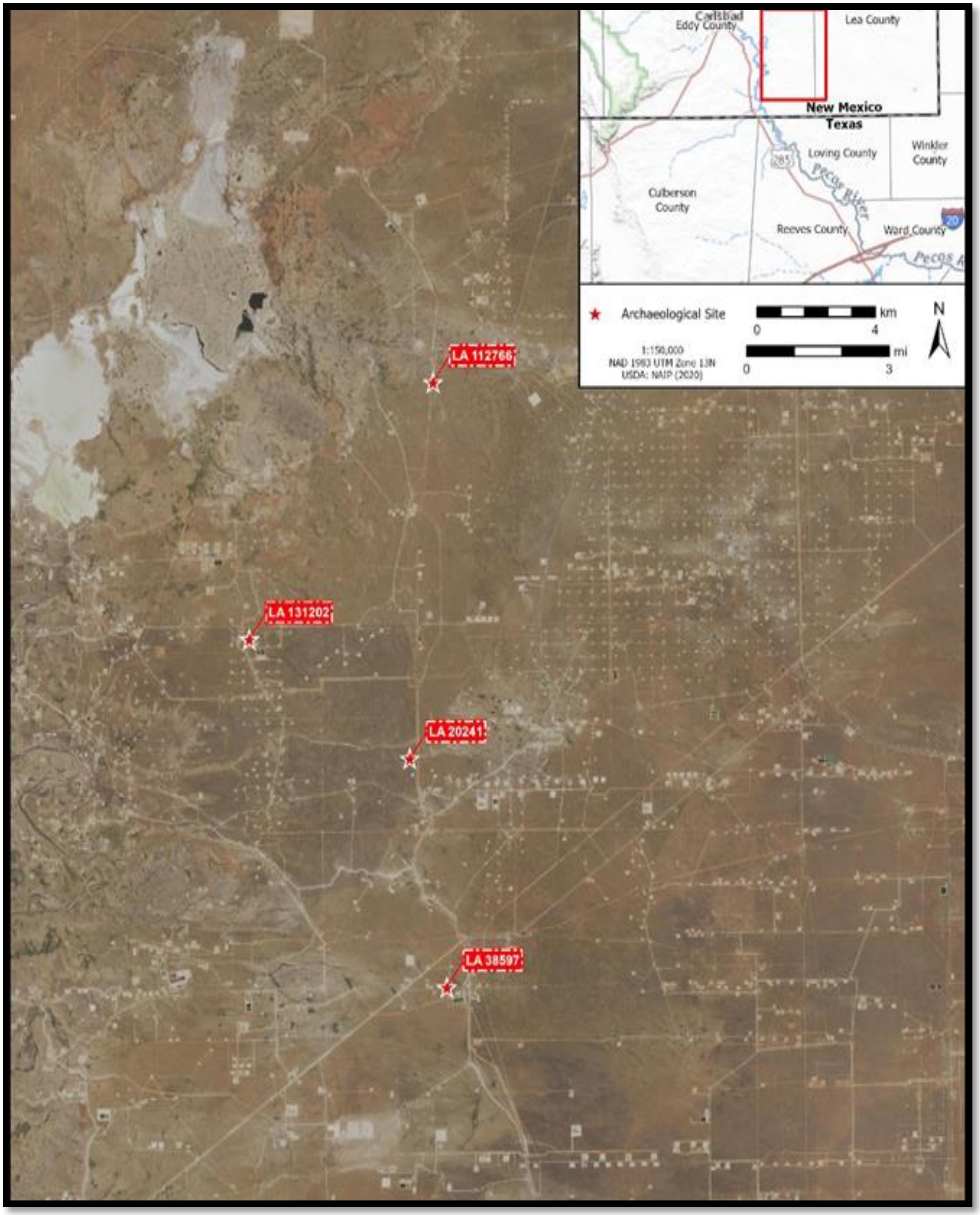


Figure 1- Location of Sites LA 20241, LA 38597, LA 112766, and LA 131202.
Map Credit: SEARCH 2022

This paper is designed to direct the reader through the investigation processes and methods chapter by chapter. Chapter 2 presents the theoretical framework used to understand the introduction of maize into foraging subsistence systems. The Marginal Zone and Mutual Causation theories were considered to understand the subsistence practices of prehistoric foraging groups as they pertain to maize.

The Permian Basin of southeast New Mexico is the focus region for this study. Chapter 3 describes the geology, environmental background, and cultural context for southeastern New Mexico, and the case study sites. The case study sites for this thesis are fully described to provide an understanding of the study area. A brief cultural history provides the human story occurring in the Permian Basin during the Archaic and Formative periods. Understanding how the groups subsisted on the land provides insight for understanding how maize became integrated into the foodways of foraging prehistoric groups.

To date, research on early maize in the Permian Basin is minimal. A synopsis of previous research as it relates to maize in the Permian Basin of southeastern New Mexico is also provided in this chapter. The purpose of this examination is to augment the current research on subsistence economies of Archaic and Formative groups in southeast New Mexico.

Chapter 4 details specialized analyses conducted on recovered materials from Sites LA 20241, LA 38597, LA 112766, and LA 131202 and my methods for interpreting the results of these analyses. The methods used for this research included conducting a literature review of early maize; examination of excavated cultural features from Sites LA 20241, LA 38597, LA 112766, and LA 131202 that produced evidence of maize:

reviewing radiocarbon dates from Sites LA 20241, LA 38597, LA 112766, and LA 131202: and examining ceramic types recovered from the case study sites. Lastly, data from Sites LA 20241, LA 38597, LA 112766, and LA 131202 was compared to other previously investigated southeastern New Mexico archaeological sites.

Chapter 5 presents the results derived from macrobotanical, phytolith, and starch studies, radiocarbon dating, and ceramics analysis. The results are presented by dataset. This chapter summarizes cultural features from Sites LA 20241, LA 38597, LA 112766, and LA 131202. Ceramics were examined in this investigation to determine if maize was traded into the Permian Basin of southeastern New Mexico.

Chapter 6 synthesizes the review of multiple datasets. The unification of the collected data is the core to the analysis presented in this thesis. The datasets are reviewed for migration patterns of maize use by Archaic and Formative groups for the Permian Basin of southeastern New Mexico. Patterns were identified and indicate that maize was exchanged within the Permian Basin of southeastern New Mexico as early as the Middle Archaic period.

Chapter 7 presents the conclusions from the examination of multiple datasets. The conclusion answers the thesis questions and provides direction for future research on early maize in southeastern New Mexico.

From the theoretical framework to the development of new hypotheses each chapter presents a different piece of data that provides enough evidence to answer the research question of when and to what extent maize was integrated into the subsistence of southeastern New Mexico prehistoric groups.

Chapter 2 - Theoretical Framework

The theoretical framework used to interpret the data recovered from this investigation include Marginal Zone and Mutual Causation theories. The Marginal Zone Theory describes societal pressures that result in cultural expansion into inhospitable territories. Mutual Causation explains the systems that influence the behavior and actions within these societies.

The Marginal Zone Theory

Marginal Zone Theory (Binford, 1968) is a systemic theory that focuses on the relationship between population pressure, environment, and substance strategies (Svizzaro and Tisdell, 2014:7). The theory predicts that human groups initially had greater freedom to choose their living situations. Small groups that populated the Americas during the Paleoindian and Archaic periods could exploit prime resource locations. Foraging yields met societal needs and population leveled remained low creating systemic balance. Without a catalyst there is no need to devote additional time and energy to increase food production. As populations increased and became denser across the landscape, competition for resources increased. Marginal Zone Theory proposes that the center hub of a society or the Nuclear Zones increase in population and begin to push outward, eventually pushing groups on the outer edges of encampments into less fertile or inhospitable environments or marginal zones (Bevan et al. 2017). The Marginal Zone theory addresses the human aspect of this investigation.

Resources were less abundant in the marginal zones, and the environment less hospitable to those who lived in them. The change in environment required a change in societal structure and a change in subsistence practices. Seasonal rounds changed to accommodate climate change, temperature change, a change in vegetation, and a change in fauna. These changes were the catalyst that spurred the development of agriculture (Svizzero and Tisdell 2014). A lack of abundant resources required prehistoric groups to develop new ways to augment their diets.

How does the Marginal Zone Theory Correlate with the Case Study Dataset Results?

The historic context of our case study sites correlates with each point identified in the Marginal Zone Theory. Due to the available water sources, cooler temperatures, and abundant resources in the Sacramento and Guadalupe mountains, these mountain ranges were the prehistoric Nuclear Zones of southeastern New Mexico. Improved climatic conditions aided in a large population increase during the Late Holocene period (Railey 2016:75). Eventually, local resources began to run out and efforts to find food increased without increasing the amount of food foraged (Murrell 2018:8). This aligns with the marginal zone context that a catalyst is required to stimulate the expansion of people into the marginal zones. Population pressure initiated the migration of prehistoric peoples of the mountainous regions into the Pecos River valley lowlands. Climatic change also supplied reliable water sources in previously arid regions within these lowland marginal zones. The presence of a population in the Marginal Zones would have attract traders and the opportunity to engage in trade when resources were abundant (Anderson 2010).

Prehistoric groups traveled north to south following an annual seasonal round that followed the Pecos River valley. Prehistoric hunter/gatherers used a mixture of foraging strategies to minimize energy expenditure, time and travel investment needed to gather resources. Monica Murrell (2018:8) explains these foraging strategies in two parts; residential mobility that moves people to food, and logistical mobility which moves food to people. The residential strategy optimizes the resources in the immediate area of camp called the foraging zone. The estimated distance an individual forages daily is 15 km from the campsite. The area outside 15 km but less than 25 km from camp is the logistical zone used during extended foraging trips by groups working on specific tasks. Beyond the logistical zone is the extended or visiting zone. This zone is not commonly used but helps foragers learn what resources are available by exploring or communicating with neighboring groups. The size of annual foraging ranges in an arid zone such as southeast New Mexico is 2,000 to 10,000 square kilometers. Generally, the larger the annual range of the round, the farther it is between patches of resources and the populations remain smaller (Murrell 2018:8). Seasonal rounds included the collection of agave during the spring and fall, yucca fruit in the summer, pine nuts, mesquite beans, and prickly pear are collected in the fall (Murrell 2018:43).

Several metates were recovered from each of the case study sites supplying evidence of plant processing. I propose that the groundstone tools were used to process naturally occurring plant resources including sumac, sunflower, cacti, saltbush, mesquite, and acorn into pulp and then dried into flour (Murrell 2018:8). The flour was for personal use and for trade with the highland Nuclear communities and with more remote communities residing in the extended/visiting zone to the south. No evidence of formal agriculture has been detected at any of the four case study sites. The absence of evidence does not mean that planting and growing maize did not occur. Planting may have occurred within the foraging zone closer to water and then the kernels could be brought to the sites for processing.

The closest old maize site pre-dating LA 112766 is Guilla Naquitz. Guilla Naquitz is located in modern Mexico, a few kilometers south of the Arizona border. The local plant processing occurring by those living in the marginal zone, as evidenced by the groundstone tools, may have produced a product used to trade with Guilla Naquitz for maize flour. Maize is not a naturally occurring cultigen in the Permian Basin of southeastern New Mexico. The very presence of maize suggests that trade was occurring. Trade represented not only the product of maize, but also the exchange of the knowledge of a new cultigen. If trade brought maize seed from the extended or visiting zones into the marginal zones during the middle Archaic it is possible that an informal form of horticulture, low-level food production without a high-energy commitment, may have been developed and adopted into the season round. The wetter, cooler climate provided easier availability to riparian zones and water resources, seeds could be tossed into these ripe soils, left to naturally grow, and then returned to for harvesting.

Mutual Causation Theory

"Mutual Causality is closely related to system dynamics. It is the measure of the flow of energy and the cycles of matter through human ecosystem" (Moran 2016:18). Every action taken involves a process or a system in which to get it accomplished (Moran 2016). When considering the subsistence economy of prehistoric groups living in the Permian Basin of southeastern New Mexico, I must consider all the components that relate to acquisition of resources. The climate, environment, fauna, flora, type of resource and other foraging groups are components that affect the abundance or absence of subsistence resources. These components interact with each other in a way that does not specifically cause a situation or event. It is a loop relationship that provides positive or negative feedback. The feedback amplifies or stabilizes the actions and reactions of populations to a stressor.

<u>How does Mutual Causation Theory Correlate with the Case Study Dataset?</u>

Mutual Causation explains the systems driving the actions and reactions of populations. The radiocarbon dataset provides the dates for multiple occupation periods ranging from Middle Archaic to Formative traditions. Groundstone evidence indicates that plant processing occurred and since maize is not naturally occurring its presence may indicate that trade was practiced as early as the Middle Archaic. With a temporal placement, identified activities, and a known environment one can deduce that there were cultural and ecological at work that caused the population to take one action or another. In this instance: Middle Archaic subsistence adaptations. Causation stressors included population levels, precipitation levels, resource diversity, time of year, etc. The nomadic nature of the Middle Archaic tradition included cyclical seasonal rounds. In this setting circumstances were fluid and change a constant. Prehistoric groups in southeastern New Mexico Permian Basin adapted their hunting and gathering to meet the conditions of these stressors.

Intergenerational transmission of knowledge is necessary to build these systems (Moran 2016). The system is passed down from one generation to the next generation to sustain the status quo. To improve the system or adapt it to current biological/ecological needs, knowledge must be built upon. In the prehistoric period of the Permian Basin of southeastern New Mexico, the system applied to tool making, hunting, foraging, trade, and eventually to horticulture.

Marginal Zone theory addresses the human aspect of the archaeological information. Mutual Causation theory addresses the systematic dynamics that both influence and are the result of the human aspect. The geological, geographic, and cultural background of the project area must be applied to these theories to understand the context and validity of these theories as applied to the research presented in this thesis.

Chapter 3 - Background

The prehistoric environment must be factored into this investigation to determine when and to what extent maize was integrated into the subsistence of southeastern New Mexico prehistoric groups. Chapter 3 provides data on the environmental setting, a prehistoric cultural context for, as well as an introduction to the case study sites.

Geological Context

During the break-up of Pangaea the Permian Period was a time of major reef building between 298.9 and 251 million years ago (mya) (Lawver 1993:228). Volcanic eruptions, during that time, blocked the sun. Temperatures dropped and photosynthesis stopped causing the collapse of food chains and the Permian extinction (251 mya) wiped out 70 percent of land animals (Nowak 2020:15). Permian-aged rock formations make up 95 percent of the present-day outcrops. The Permian Basin is composed of sedimentary rock that contains the mid-continent oil field providence. The Delaware Basin has the thickest deposits of rocks from the Permian geologic period (Land 2013:187). Beneath the surface of this vast region is one of the richest concentrations of fossil fuels in the nation (Railey 2016:1). The Permian Basin is comprised of three sections, the Midland Basin, the Central Basin Platform, and the Delaware Basin. This investigation will focus on archaeological sites located in the Delaware Basin (Figure 2). The Delaware Basin is a hydrocarbon rich sedimentary basin and covers 6.4 million acres. It is the deepest of the Permian sub-basins with the thickest deposits of rock (Kealy et al. 2019:11).

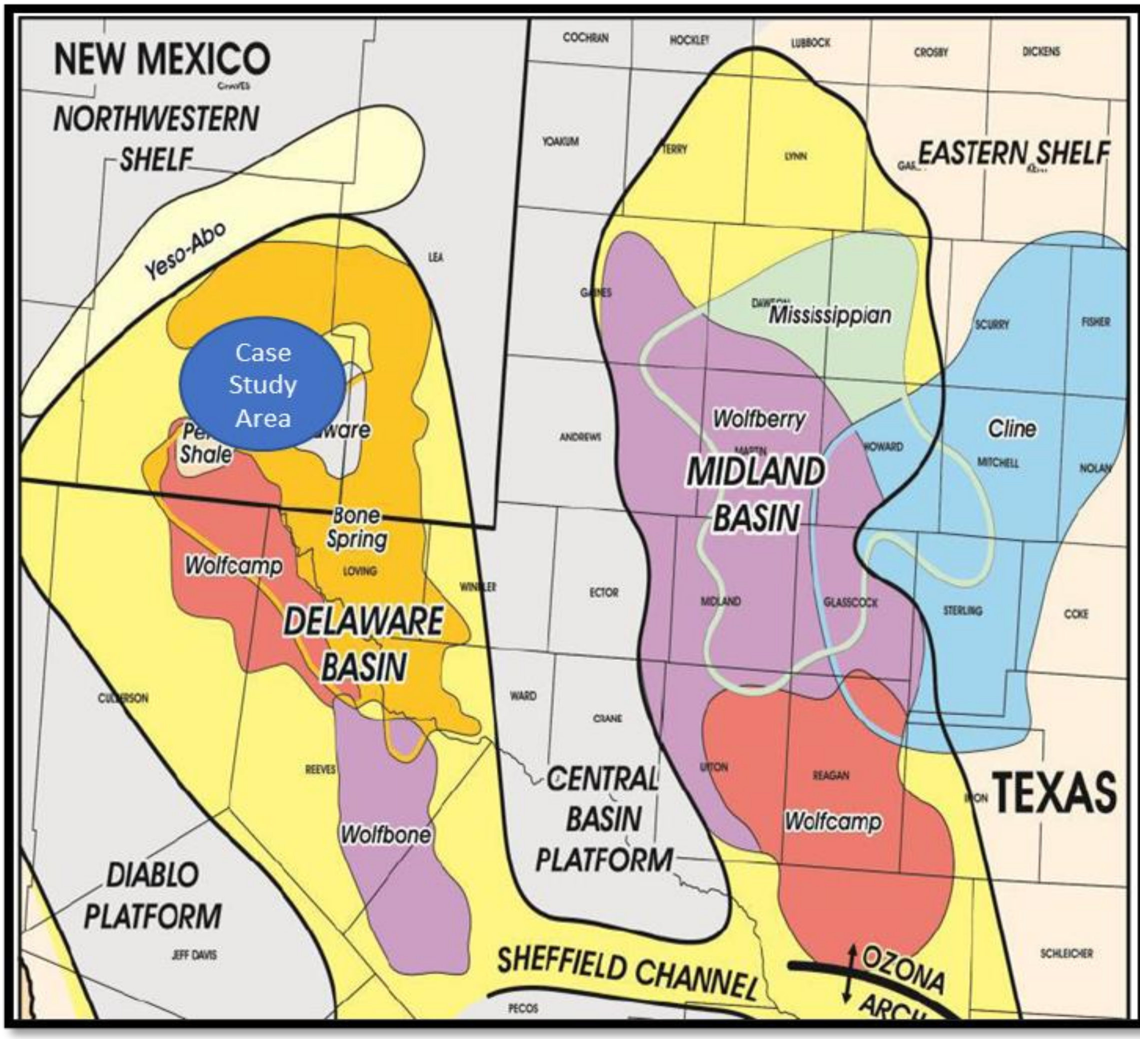


Figure 2- Map of Permian Basin Showing the Case Study Area
Adapted from Radio Oklahoma 2016

Southeastern New Mexico's geographic location rests between the Great Plains and the Basin and Range physiographic provinces (Katz and Katz 2021:III-1). The Pecos Valley, Llano Estacado, and Sacramento Slope physiographic sub-provinces make-up the southeastern portion of New Mexico. The Pecos Valley consists of a large central plain with the Llano Estacado to the east and the Sacramento Slope to the west. The Pecos Valley is the largest of the three physiographic sections. The Pecos Valley includes most of De Baca, Eddy, Chaves, and Lea counties. The Mescalero Plain is a smaller section between the Pecos Valley and the Llano Estacado (Katz and Katz 2021:III-2).

Environmental Setting

The Delaware Basin portion of the Permian Basin is classified as Desert Grassland. The region was once covered by grasslands before becoming overgrazed in the last 150 years. Overgrazing altered the flora into a transitional composition containing a large alluvial eolian sand sheet with stabilized coppice and parabolic dunes (Railey 2016:42). The vegetation currently includes a variety of grasses, forb, and shrub species. Mesquite, creosote, soap-tree yucca, Mormon tea, prickly pear, black grama grass, burweed, snakeweed, and sagebrush are a sample of the plants in the region (Brown 2022:2.1).

Several plant resources are present across the region. The main fuel woods include mesquite, oak, cholla, juniper, creosote, sumac, and sunflower. Potential plant foods include sumac, sunflower, cacti, saltbush, mesquite, acorns, and dropseed that can be harvested from summer to fall. The east-facing foothills drain downward into the Pecos Valley. The Pecos River valley corridor contains an array of plant species (Murrell 2018:8-9).

The arid climate of the Altithermal Period (5000–2500 BC), an era when temperatures in western North America were 2°C (35.6 F) warmer causing the lakes in the American Great Basin to dry up (American Metrological Society 2012). This warming period continued into at least the early portion of the Middle Archaic period. Conditions improved during the interval 3000–2000 BC., when the climate became wetter and/or cooler. During this Late Holocene Wet Period (2500 BC–AD 900) there was probably a proliferation and resurgence of reliable sources of surface water and a widespread expansion and enrichment of the available biomass (Railey 2016:73). Currently, Eddy County has a semi-arid climate with a monsoon season June through September resulting in an average annual precipitation of 12.84 inches. The average annual temperature is 78.6 Fahrenheit (Brown 2022:2.1).

<u>Cultural Context</u>

For this investigation, I use the cultural divisions presented in the Permian Basin Research Design (; Railey 2016).

Table 1. Cultural Timeframes

Tradition	**Time Period**
Paleoindian	11,500–7000 BC
Early Archaic	7000–3200 BC
Middle Archaic	3200–1800 BC
Late Archaic	1800 BC–AD 500
Early Formative	AD 500–AD 1100
Late Formative	AD 1100–AD 1450
Post-Formative	AD 1450–AD 1750

The lack of maize evidence at Paleoindian sites, prompted this researcher to begin the cultural context at the Archaic period and continue through the Late Formative period. Figure 3Adapted from Dello-Russo 2006: Figure 1:28) shows early maize sites in the southwest in relation to the case study sites. Early maize sites have Middle Archaic dates and are documented west of the Pecos River. The map is adapted to show the movement of maize hypothesized in Chapter 5 in contrast to the current commonly accepted movement of maize.

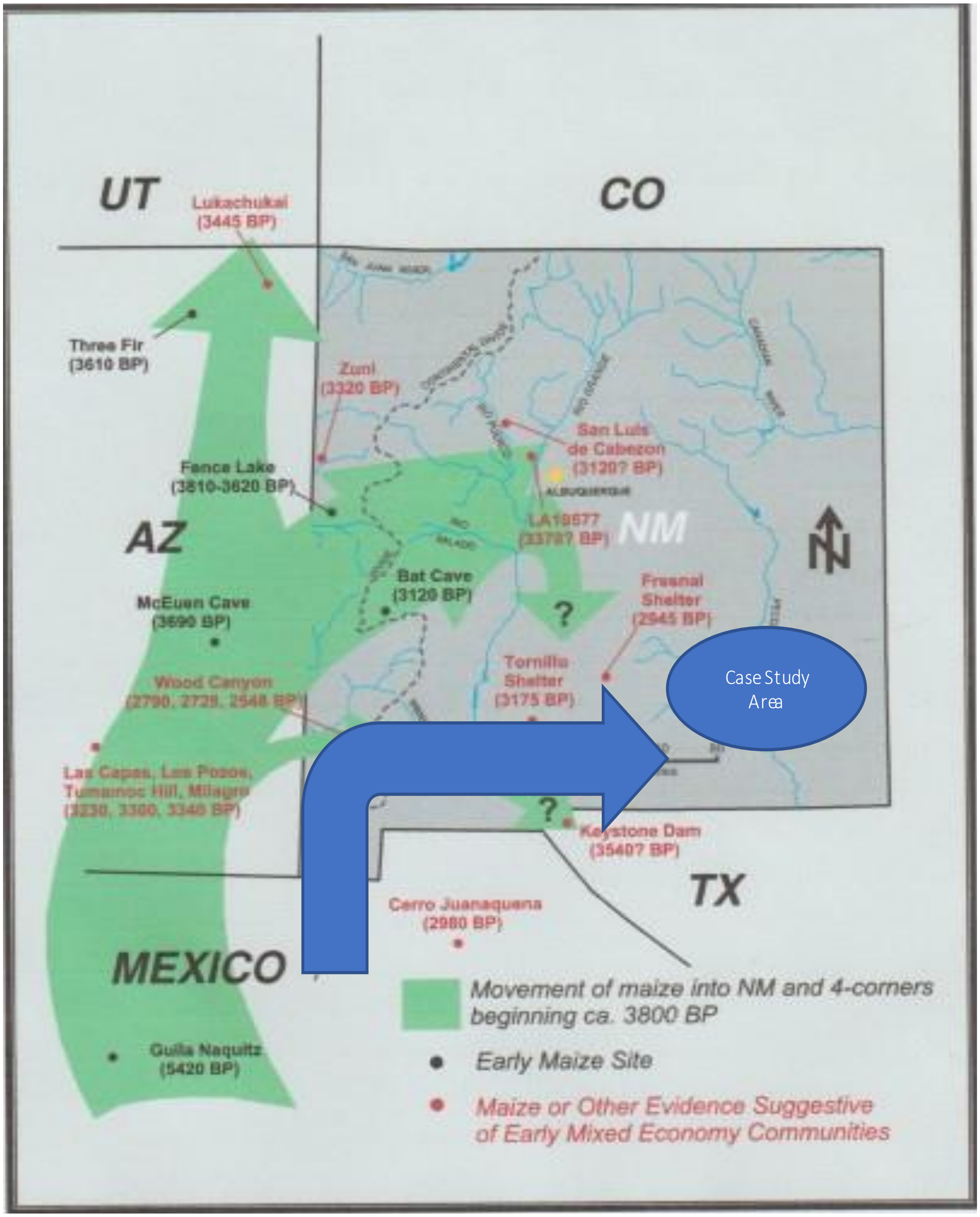


Figure 3- Early Maize Sites in Relation to the Case Study Sites.
Adapted: Dello-Russo 2006: (Figure 1:28)

Archaic populations began living in larger groups and enjoyed a larger variety of foods and grains. During this period, maize horticulture became widespread in the Southwest and was incorporated into the broad spectrum of a foraging economy (Cordell and McBrinn 2012:136-149). Earl maize cultivation would have involved the planting of chapalote maize, an early variety of maize defined in Mexico and adapted to lowland setting and shorter growing seasons (Matson 1999:122). The Permian Basin of southeastern New Mexico does not have clear archaeological evidence of horticulture until the Early Formative period (Railey 2016:74). Evidence of pit structures, storage pits and midden deposits are not found within the case study area. This same period of abundance during the Late Archaic is marked by the widespread use of hearths, roasting pits, and burned rock features found across the Permian Basin of southeastern New Mexico suggesting extensive foraging of the landscape, rather than the development of horticulture (Miller 2016:19).

The wetter and cooler climate and abundance of water during the Middle Archaic period would have increased opportunities for foraging and hunting. Recent studies indicate that Late Archaic foragers shifted their residence patterns in respect to changing rainfall patterns (Vierra 2018:5)

The environment during the Formative period (AD 500–1450) included extensive grasslands. During this period subsistence economies adopted horticultural practices to supplement hunting and gathering. Evidence of horticulture of maize, squash and beans becomes more frequent. Ceramics, storage pits, and above ground room blocks are present in archaeological sites dating to the Formative period (Katz and Katz III:2). LA 43414, known as the Merchant Site is one example. LA 43414 is a Late Formative (AD 1270– AD

1450) period village approximately 50 miles East of the case study sites. The Merchant Site contains 22 surface room blocks, pit structures, and three middens (Miller 2016:105).

A Brief History of Old Maize Sites in the Southwest

Analysis of early maize in the areas surrounding our case study sites has important implications to understanding the timing, context, and nature of early horticulture in the region. Multiple AMS radiocarbon dates firmly establish that maize was introduced to the southwestern United States no later than 2100 BC (Merrill 2009:21020). The oldest known maize macrofossils were recovered from Guila Naquitz Cave in the southern Mexican state of Oaxaca. These macrofossils date to 4280 BC. The earliest evidence for maize in the southwestern United States comes from three open sites and two rock shelters in Arizona and western New Mexico ranging in elevation from 700 to 2200 amsl.

Clearwater and Las Capas are located in the basin and range country of the upper Sonoran Desert. McEuen Cave is found in a deep canyon in the eastern Gila River valley. The Old Corn site is in an upland valley on the southeastern edge of the Colorado Plateau, and the Three Fir Shelter is situated on the central Colorado Plateau, near the north rim of Black Mesa (Merrill 2009:21021). Maize appears almost simultaneously in these upland and lowland sites. Fifteen radiocarbon dates on maize macrofossils recovered from these five sites cluster to 2100 BC.

The Case Study Sites

Site LA 20241

The site was originally recorded in 1979 (Aylward; NMCRIS No. 15054). In 2005 Lone Mountain Archaeological Services revisited Site LA 20241 (Travis et al 2005; NMCRIS No. 92163). The site record was updated in 2018 and 2019 (SEARCH 2019;

NMCRIS No. 143340). The site is on an east-west trending dunal ridge at 1,048 m (3,439 ft) above mean sea level (amsl). An intermittent drainage is 68.2 m (223.7 ft) from the site to the southwest (Cleeland et al. 2020:58). Site LA 20241 is an extensive artifact scatter with features primarily affiliated with the Early to Late Formative period (AD 500–1400) and an earlier Late Archaic occupation (1800 BC–AD 500). In February and March 2021, data recovery investigations excavated only the northwest portion of the site. (Cleeland et al 2021a).

The 2021 data recovery identified 48 cultural features, of these, 12 features contained evidence of maize (Figure 4, Cleeland et al. 2021a). The cultural material collected from Site LA 20241 consists of 1,729 artifacts. The assemblage includes: 53 ceramics, 1,554 debitage, 35 lithic tools, 13 shell fragments, 2 seeds, 1 metal nail, and 71 groundstone. The groundstone collection includes five complete metates, two complete manos, and one complete pestle. One maize feature (Feature 32) contained a complete metate. Overall, 99 soil samples were collected from the site.

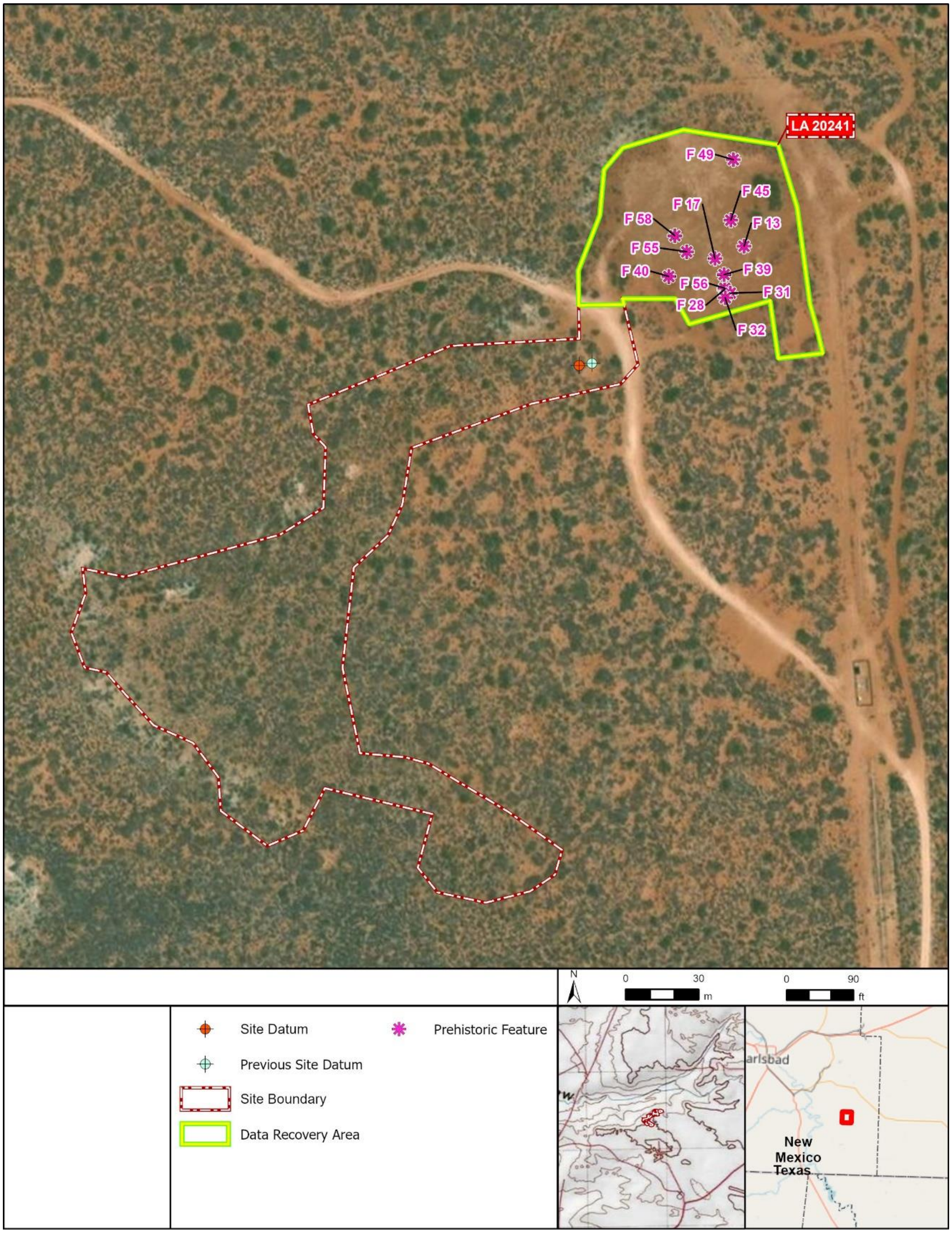


Figure 4- Site LA 20241 Overview Showing Features with Evidence of Maize from the Excavated Portion of the Site.
Map Credit: SEARCH

Site LA 38597

Originally recorded in 2005 (Travis et al 2005; NMCRIS No. 92163), again in 2013 (Pangburn et al. 2013; NMCRIS No. 125793), then twice again in 2019 (SEARCH 2019; NMCRIS No. 143340). The site is on a low hill amidst a coppice dune field at 1,026.6 m (3,374 ft) amsl. An intermittent drainage is located 2,057 m (6,748 ft) to the northeast (Cleeland et al., 2020b:41). Site LA 38597 is a prehistoric occupation affiliated to the Middle Archaic through the Formative periods 3200 BC-AD 1400 based on radiocarbon dates, diagnostic lithics and ceramics. The excavated portion of the site contains a large artifact scatter and 27 features.

In February and March 2021 data recovery excavation efforts located 27 cultural features, of these, six features contained evidence of maize (Figure 5). The cultural material collected from Site LA 38597 consists of 7,034 artifacts. The assemblage includes: 87 ceramics, 6,811 pieces of debitage, 29 lithic tools, 8 shell fragments, 4 faunal fragments, 6 metal nails, and 89 groundstone. The groundstone assemblage includes three complete metates. Features with maize residue and artifacts include Feature 11, Feature 12, Feature 32, and Feature 33. Overall, 101 soil samples were collected.

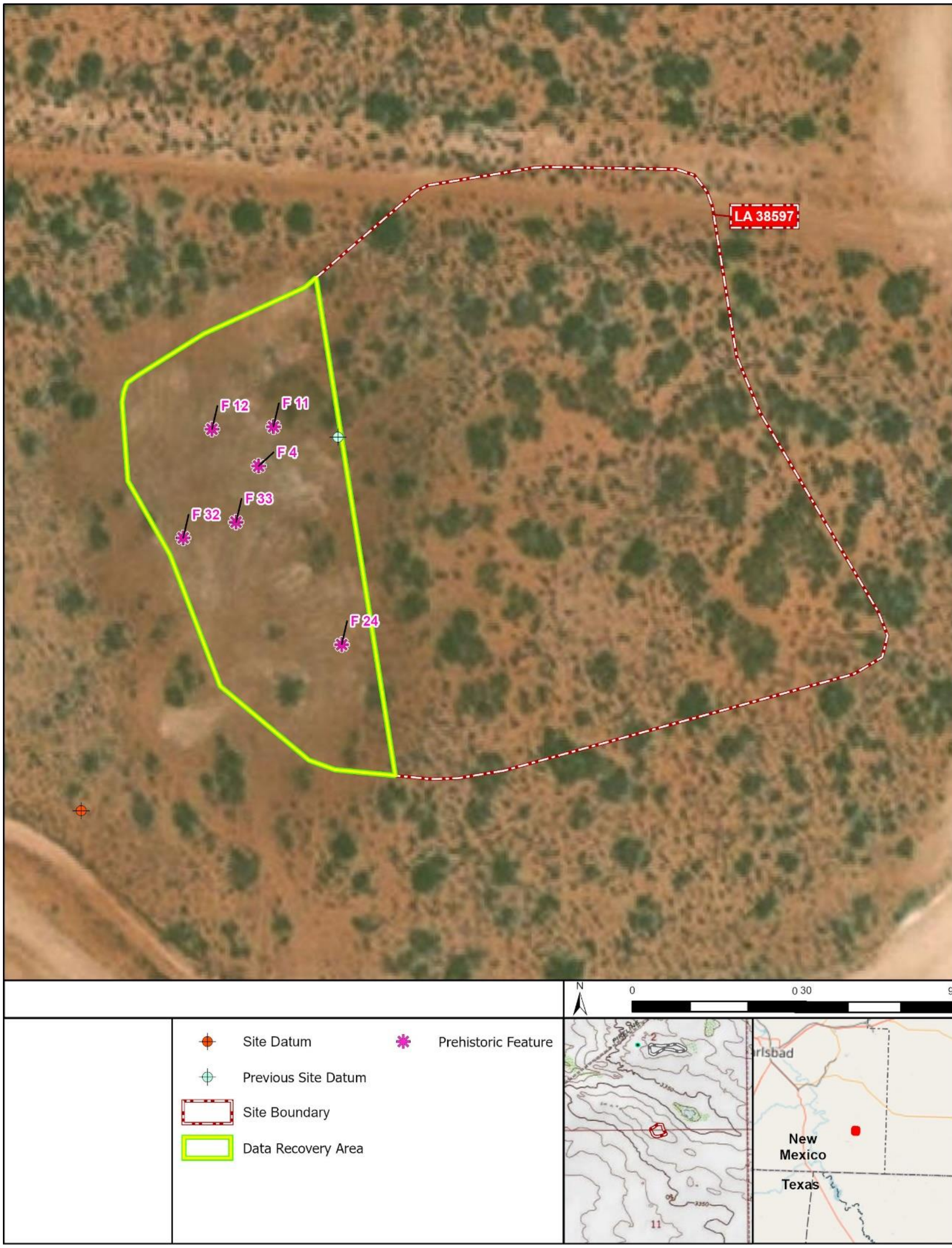


Figure 5- Site LA 38597 Overview Showing Features with Evidence of Maize from the Excavated Portion of the Site
Map Credit: SEARCH

Site LA 112766

Site LA 112766 is a previously recorded prehistoric site that dates to the Early Formative period (AD 200–AD 1400). The site was originally recorded in 1996 (Flynn et al. 1996 NMCRIS No. 51982). The site is on a dune field on the crest of a low hill at an elevation of 972 m (3,189 ft) amsl. An intermittent drainage is 29.8 m (97.8 ft) to the north (Cleeland et al. 2020a:49).

In February and March 2021, data recovery efforts on the excavated portion of the site yielded 10 cultural features; of these, ten features contained evidence of maize. (Figure 4). The cultural materials recovered from Site LA 112766 consists of 1,287 artifacts. The artifact assemblage incudes: 5 ceramics, 1,227 pieces of debitage, 7 lithic tools, 18 faunal remains, and 30 groundstone tools, including a complete metate and matching mano. No cultural materials were in any maize features. Overall, 108 soil samples were collected (Goar et al. 2021).

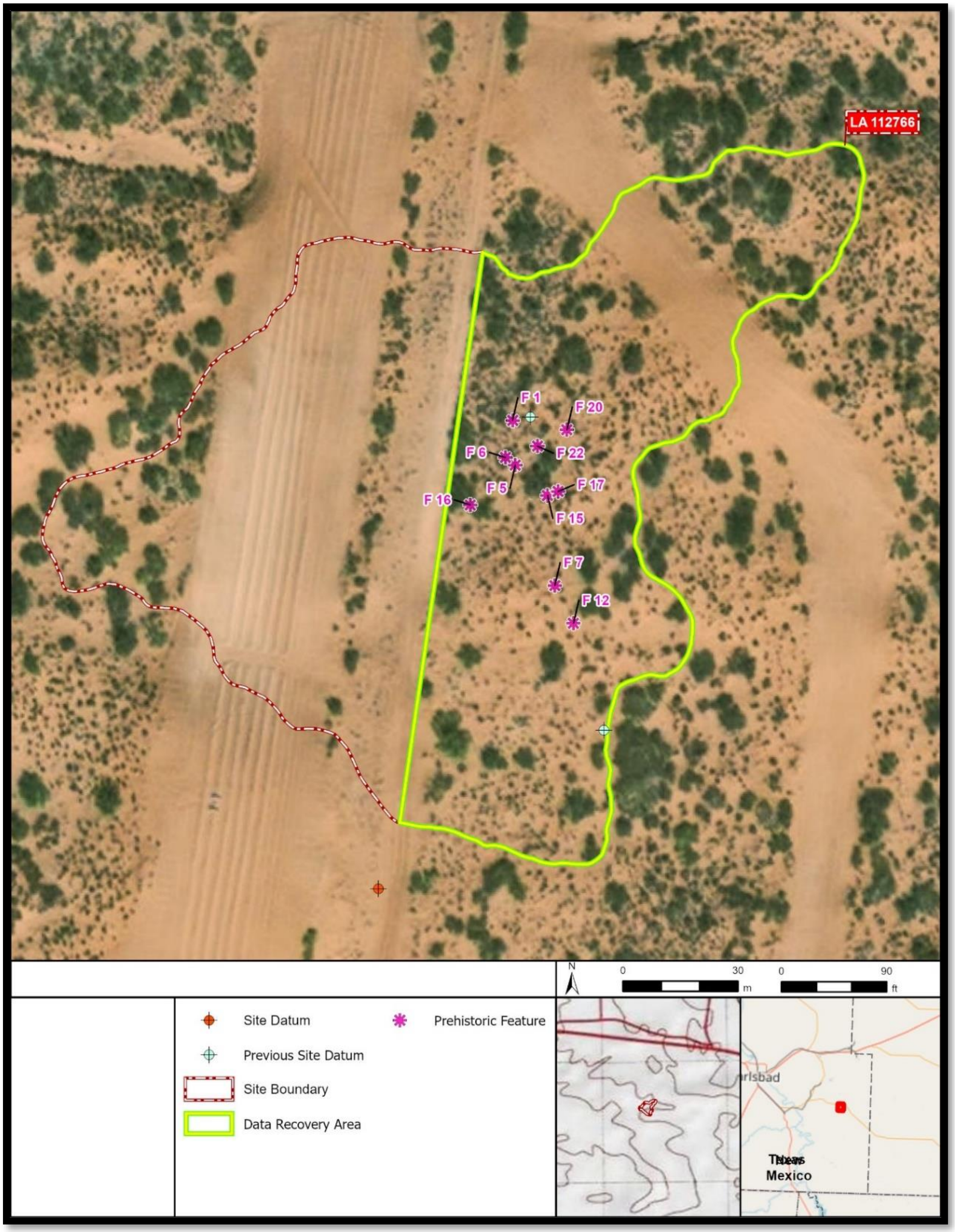


Figure 6- Site LA 112766 Overview Showing Features with Evidence of Maize from the Excavated Portion of the Site.
Map Credit: SEARCH 2022

Site LA 131202

Site LA 131202 is a prehistoric site affiliated with Jornada Mogollon (AD 200–AD 1400). The site is located on a dunal ridge with many deflated areas exposing caliche gravels. Site elevation is 996 m (3,267 ft) amsl. An intermittent drainage is located 261 m (857 ft) to the northeast (Cleeland et al. 2020:68).

In February and March 2021 data recovery excavation efforts documented seven cultural features: three features contained evidence of maize (Figure 7). Cultural materials recovered from Site LA 131202 consist of 1,285 artifacts. The artifact assemblage includes:1,255 debitage, 127 lithic tools, 1 faunal remain, and 1 shell fragment. No cultural material was associated with any maize features. Eight soil samples were collected during data collection (Goar et al. 2021).

Figure 7- Site 131202 Overview Showing Features with Evidence of Maize from the Excavated Portion of the Site.
Map Credit: SEARCH 2022

Sites LA 20241, LA 38597, LA 112766 and LA 131202 are located on the Permian-aged sedimentary rock that makes up the Delaware Basin. During the Late Holocene Wet Period (2500 BC–AD 900) Archaic populations began living in larger groups and enjoyed a larger variety of foods and grains. Analysis of recovered cultural material and relative dating, indicate that Sites LA 20241, LA 38597, LA 112766 and LA 131202 are multi-component with occupation periods ranging from the Late Archaic to the Late Formative periods. Additionally, specialized analyses indicate that maize was present at these sites.

Chapter 4 - Research Methods

Methods applied to determine when and to what extent maize use was present in the Permian Basin of southeastern New Mexico include: identification of cultural features containing evidence of maize; plotting features identified as having maize and the associated radiocarbon dates; determination of the amount of maize; identification of documented ceramics types, literature review of previously investigated maize sites within southeastern New Mexico, and comparison of the case study sites with each other and with the previously identified maize sites data set. Samples sent for analysis (macrobotanical, phytolith, starch, and charred remains) were extracted from the same excavation level and depth within the feature guaranteeing that radiocarbon dates matched the presence of maize.

<u>Excavation of Features and In-field Collection of Sediment Samples.</u>

Feature excavation was executed manually by bisecting and excavating in 5.0 cm (2.0 in) arbitrary levels and at least 5.0 cm (2.0 in) below the base of the feature. Removed sediments were screened using 1/8-inch steel mesh screen. Feature soil samples were stored in linen textile samples bags and transported to the laboratory for analyses.

<u>Laboratory Processing of Sediment Samples</u>

At the laboratory, sediment samples were cataloged, then divided in half. One half underwent the flotation process. The light fraction was sent for macrobotanical analyses and identified charred organics were sent for Accelerated Mass Spectrometry (AMS) radiocarbon dating. The remaining half was divided in half again and shipped to two different analysts. Dr. Linda Perry, independent consultant, conducted the starch analyses and Linda Scott-Cummings, PaleoResearch Institute, conducted the phytolith analyses.

Flotation is a process of recovering organic remains from archaeological sediments by using water to separate heavy or soluble inorganic particles called heavy fraction, from plant parts and animal bone, called light fraction. I used a Flote-Tech Model A1 recirculation flotation tank to float the soil samples from the case study sites (Figure 8). Rising water lifts the botanical and charred remains from the sediment causing it to spill onto the bag in the opposite bin (Figure 9). Heavier materials stay in the first screened bin. Both the light fraction and heavy fraction bags were dried for 24 hours.

Figure 8- Introducing sediments to the water bath.
Photograph credit: SEARCH 2022

Figure 9- Flotation: Capturing the light fraction.
Photograph Credit: SEARCH 2022

Once dry, the samples were prepared for analysis. The light fraction was poured onto a tray and tweezers were used to separate the charred remains from the sample. The charred remains were placed into a small screw-top canister and placed into double 4 mil polypropylene bags. Botanical material was placed into a paper bag with provenience information written on it, then into a zip-top bag. Each sample was documented and shipped to the analyst. Charred remains were shipped to Beta Analytic for radiocarbon dating and to Dr. Michael Diehl, Desert Archaeology for macrobotanical identification. The heavy fraction was hand sorted and analyzed under magnification in the lab for identification of micro-flakes and faunal remains.

Completed starch, phytolith, and macrobotanical analyses were reviewed to identify which features contained evidence of maize. The non-maize features were not included in this study.

Plotting Maize Features and Radiocarbon Dates

Radiocarbon dating was completed on the wood charcoal and two charred seeds harvested during the flotation process. Radiocarbon dates from cultural features with maize, determined when maize was present at each cultural site. Radiocarbon dates were plotted on Box and Whisker graphs to easily visualize the chronological patterns for each site.

Determining the Amount of Maize in Each Feature

Starch, phytolith, and macrobotanical analyses reports provide detailed information on the presence of maize in a specific feature and the quantity of maize present in each sample (Cleeland et al. 2022; Goar et al. 2022). The entire macrobotanical sample for each site was analyzed to identify organic matter. The phytolith analysis analyzed 15 milliliters (ml) of sediment. Starch analysis analyzed 25 ml of soil sediment from each submitted sample. The starch analyst identified maize grains and quantified them per feature (Cleeland et al. 2022; Goar et al. 2022). From this data, I created histograms for the starch analysis.

Identification of ceramics

Ceramics type, and decoration were analyzed by Michael P. Marshall, Cibola Research Consultant, and Dr. David V. Hill Metropolitan State University of Denver, conducted the petrographic analysis for the ceramic assemblage (Cleeland et al. 2022; Goar et al. 2022). Non-local ceramics may indicate trade or exchange relationships corresponding with the presence of maize in the feature (Cleeland et al. 2022; Goar et al. 2022). This information recovered from ceramics aided in understanding and interpreting evidence of maize in the Permian Basin during the Formative period. It must be noted that unlike the other samples that derived from features, the analyzed ceramic sample was derived from surface and sub-surface context across the site.

Literature review of previously identified maize sites

A review of 18 peer-reviewed academic papers and excavation reports was conducted to identify previously recorded maize sites in southeast New Mexico. The literature included: a review of site data filed with the New Mexico Cultural Resource Information System (NMCRIS), a search through Academia for peer reviewed articles, networking, and website searches. The purpose of this research was to catalog the geographic locations and chronological placement and cultural affiliation of previously recorded maize sites.

Research methods were used to identify cultural features containing evidence of maize and the quantity of maize recovered from each feature. Associating radiocarbon dates with the features containing evidence of maize guided the literature review of previously investigated maize sites within southeastern New Mexico. A comparison of the case study sites with each other and with the previously identified maize sites data set provided an outline of the integration of maize into prehistoric society. Results derived from macrobotanical, phytolith, starch, radiocarbon dating and ceramic analyses supplied the data used in the research.

Chapter 5 – Dataset Results

This chapter presents the results of macrobotanical, phytolith, starch, radiocarbon dating, and ceramic analyses for Sites LA 20241, LA 38597, LA 112766, and LA 131202. Trace amounts of maize in the macrobotanical, phytolith, and starch sediment samples represent the presence of maize. Radiocarbon dating places the sites chronologically. Lastly, ceramics inform possible storage, chronology, and potential trade locales. These datasets are used to plot the case study sites chronologically among previously recorded maize sites.

Table *2* lists the case study sites, associated datasets, and number of samples sent for analysis per dataset. The cultural features with no evidence of maize were not included in the results section.

Table 2. Quantity of Samples by Dataset

Site	Ceramics	Starch	Phytolith	Macrobotanical	C14
LA 20241	56	14	14	25	19
LA 38597	87	16	16	25	21
LA 112766	5	8	12	15	7
LA 131202	0	5	8	5	7
Total	**148**	**43**	**50**	**70**	**54**

First, I determined which cultural features, from each case study site, contained evidence of maize based on macrobotanical, phytolith, and starch analyses results.

<u>Macrobotanical Dataset</u>

The paleoethnobotanical research was completed by Dr. Michael Diehl, Desert Archaeology in Tucson, Arizona (Cleeland et al. 2022; Goar et al. 2022). Of the 70 samples sent for macrobotanical analysis, one yielded a single maize cupule. The cupule was recovered from Feature 3 at Site LA 131202 and was not radiocarbon dated. Other identified macrobotanical specimens of economic importance include acacia/mesquite. Saltbush was identified in Site LA 20241; Caltrop and Loco-like seeds were identified in Site LA 38597. The Caltrop and Loco seeds from Site LA 38597, were radiocarbon dated.

Pollen, Starch and Phytolith Washes

Washes were performed on six artifacts to extract remaining residue for pollen, starch and phytolith analyses. Two metates from LA 20241, a metate and a pestle with a small round impression from LA 38597, and paired metate and mano from LA 112766.

LA 20241

"Pollen Analysis from two complete metates yielded different results. Maize residue was identified on metate 1 shown in Figure 10. The Maize residue indicates that the metate was used to grind maize (Scott-Cummings 2022). In addition, this metate yielded damaged Commelina seed phytoliths suggesting that the metate was used for grinding dayflower seeds and fibers consistent with cotton, suggesting that clothing was worn by the user or users of the metate (Scott-Cummings 2022). Metate 2, a double-sided metate, shown in Figure 11 did not yield conclusive evidence of its use" (Scott-Cummings 2022:17).

Figure 10 - Metate 1 recovered from Feature 32 on Site LA 20241
Photograph Credit: Author

Figure 11- Metate 2 recovered from Site LA 20241
Photograph Credit: Author

LA 38597

The pollen, starch and phytolith analyses washes on a recovered metate (Figure 12) and pestle (Figure 13) revealed maize. The recovery of a torn maize pollen on the pestle indicates that it was used for pounding or grinding maize (Scott-Cummings 2022:18). The phytolith analysis of the mano identified sub-angular starch. According to Scott-Cummngs (2022:18) sub-angular starch is not diagnostic of maize, however, its presence is consistent with use of the mano to grind maize because this type of non-diagnostic starch is also produced in maize kernels."

Figure 12- Metate recovered from Site LA 38597
Photograph Credit: Author

Figure 13- Pestle with round indention recovered from Feature 32 on Site LA 38597
Photograph Credit: Author

LA 112766

Sunflower, and dayflower starch were identified on the paired metate and mano (Figure 14 and Figure 15). Amaranthaceae were gathered from early spring through summer and can be eaten raw. Scott–Cummings (2022:10) explains that “seeds are often dried, ground into meal, and made into mushes cakes. The leaves were eaten fresh in the spring or cooked throughout the growing season. Older Amaranthus leaves provide iron and vitamin C, whereas young Amaranthus leaves contain significant amounts of protein, calcium, phosphorus, potassium, vitamin A, and vitamin C.”

Amaranthus poultices were used to reduce swellings and to soothe aching teeth. Leaf tea was used to stop bleeding, as well as to treat dysentery, ulcers, diarrhea, mouth sores, mild heart, lung, and liver disorders, sore throats, and hoarseness. Amaranth contains abundant iron and is given to those lacking iron in their diet. Various groups used the leaves to make soap for washing bandage and linens used to treat illnesses" (Scott-Cummings 2022:10).

Figure 14- Paired Metate and Mano, In Situ, at Feature 5, Site LA 112766
Photograph Credit: Author

Figure 15- Paired Metate and Mano recovered from Feature 5 at Site LA 112766.
Photograph Credit: Author

Phytolith Dataset

Phytolith analysis was performed by PaleoResearch Institute and supervised by Dr. Linda Scott-Cummings (Cleeland et al. 2022; Goar et al. 2022). This section presents the results of Dr. Scott-Cummings analysis on soil samples.

LA 20241 - Recovery of phytoliths representing Festucoid (cool season), Chloridoid (short), and Panicoid (tall) grasses indicate a mixed grass vegetation community. Bulliforms and elongates are typical of grasses and are probably present representing the local vegetation communities. Recovery of *Commelina erecta* seed phytoliths in sediments. Cyperaceae phytoliths were recovered suggesting either local growth of or processing sedges (Scott-Cummings 2021)

LA 38597 - The phytolith signatures were dominated by *Larrea*-type phytoliths, suggesting local growth of creosote bush or by phytoliths representing grasses. Phytoliths representing grasses are usually the dominant element of phytolith records; recovery of large quantities of morphotypes typical of *Larrea* seems unusual. It is possible creosote bush colonized abandoned pit features as they filled. Burning creosote bush releases a pungent odor. For this reason, there is interpretive value in the large quantities of phytoliths suggesting the presence of this plant. According to Scott-Cummings, 2021 analysis report, either it grew in the features after their abandonment or the wood was burned. Ethnographic accounts indicate creosote bush wood was burned as fuel, suggesting we should disregard the odor produced and accept this wood as an acceptable fuel source.

Recovery of phytoliths representing Festucoid (cool season), Chloridoid (short), and Panicoid (tall) grasses indicate a mixed grass vegetation community. Bulliforms and elongates are typical of grasses and are probably present representing the local vegetation communities. Recovery of *Commelina erecta* seed phytoliths in sediments from Features 10, 11, 27, and 32 suggests the possibility that day flower seeds were processed or that quail was processed (Scott-Cummings 2021).

LA 112766 - Features 1, 5, and 6, yielded signatures dominated by phytoliths indicating grasses. Bulliforms and elongates were abundant in each of these samples. Rondels, Chloridoid saddles, and Phytoliths typical of Larrea were present, but not abundant.

Feature 5 yielded human hair fragments, sub-angular starches that occur in maize, but also in other grass seeds, diatoms, and sponge spicules, as well as a moderately large quantity of unidentified fibers.

Feature 6 also yielded a moderately large quantity of unidentified fibers.

Feature 7 yielded slightly smaller frequencies of phytoliths representing grasses, and an increase in phytoliths typical of Larrea (creosote).

Features 8, 12, 15, 16, 17, 20, 21, and 22 all yielded phytolith signatures dominated or heavily dominated by Larrea-type phytoliths, suggesting the possibility that creosote bush grew in the abandoned features or that creosote bush wood was burned

LA 131202 - The phytolith record is heavily dominated by Larrea-type phytoliths. Only This phytolith signature displays evidence of rondels and trapeziforms, indicating Festucoid or cool season grasses; Chloridoid saddles typical of short grasses; and bilobate and cross-shaped phytoliths indicating Panicoid or tall grasses. Moderate quantities of elongates and small quantities of bulliforms and trichomes also suggest grasses. Samples heavily dominated by Larrea-type phytoliths, representing creosote bush, exhibited a very limited quantity of grass short cells, but usually did contain bulliforms, elongates, and trichomes typical of grasses. Fibers typical of Gossypium (cotton) were observed in Features F1 and were more numerous in Feature F2. Feature F1 exhibited a centric starch typical of grass seeds, suggesting processing grass seeds. In general, the phytoliths were well preserved in these features (Scott-Cummings 2021)

Starch Dataset

Starch analysis was conducted by Dr. Linda Perry, independent consultant (Cleeland et al. 2022; Goar et al. 2022). This section presents the results of Dr. Perry's analysis. A results table is provided for each case study site. Histograms illustrate the proportion of maize starch grains observed for each feature. Maize starch grains are represented as 25 ml of sediment.

LA 20241 - Preservation was very good across the samples with all recovered starch grains occurring in what appeared to be intact, native states (Cleeland et al. 2022a). Maize is the predominant starch grain in the assemblage (Table 3, Figure 16) with 32 grains and two probable maize samples. This accounted for 86 percent of the recovered grains in the analyzed sample.

Table 3. Site LA 20241 Feature Types and Maize Grains

Feature Designation	Feature type	Depth (cmbs)	Number of Maize Grains
13	Thermal stain	53–67	1
17	Thermal stain	40–53	4
28	Thermal stain with a fire-cracked rock concentration	75–85	1
31	Thermal stain	115–125	5
32	Burned caliche concentration	35–40	5
39	Thermal stain	105–118	1
40	Thermal stain with a fire-cracked rock concentration	70–80	1
45	Fire-cracked rock concentration	20–25	6
49	Thermal stain with burned caliche	60–65	1
55	Thermal stain with burned caliche	11–28	2
56	Thermal stain	107–112	3
58	Thermal stain with burned caliche	15–25	2

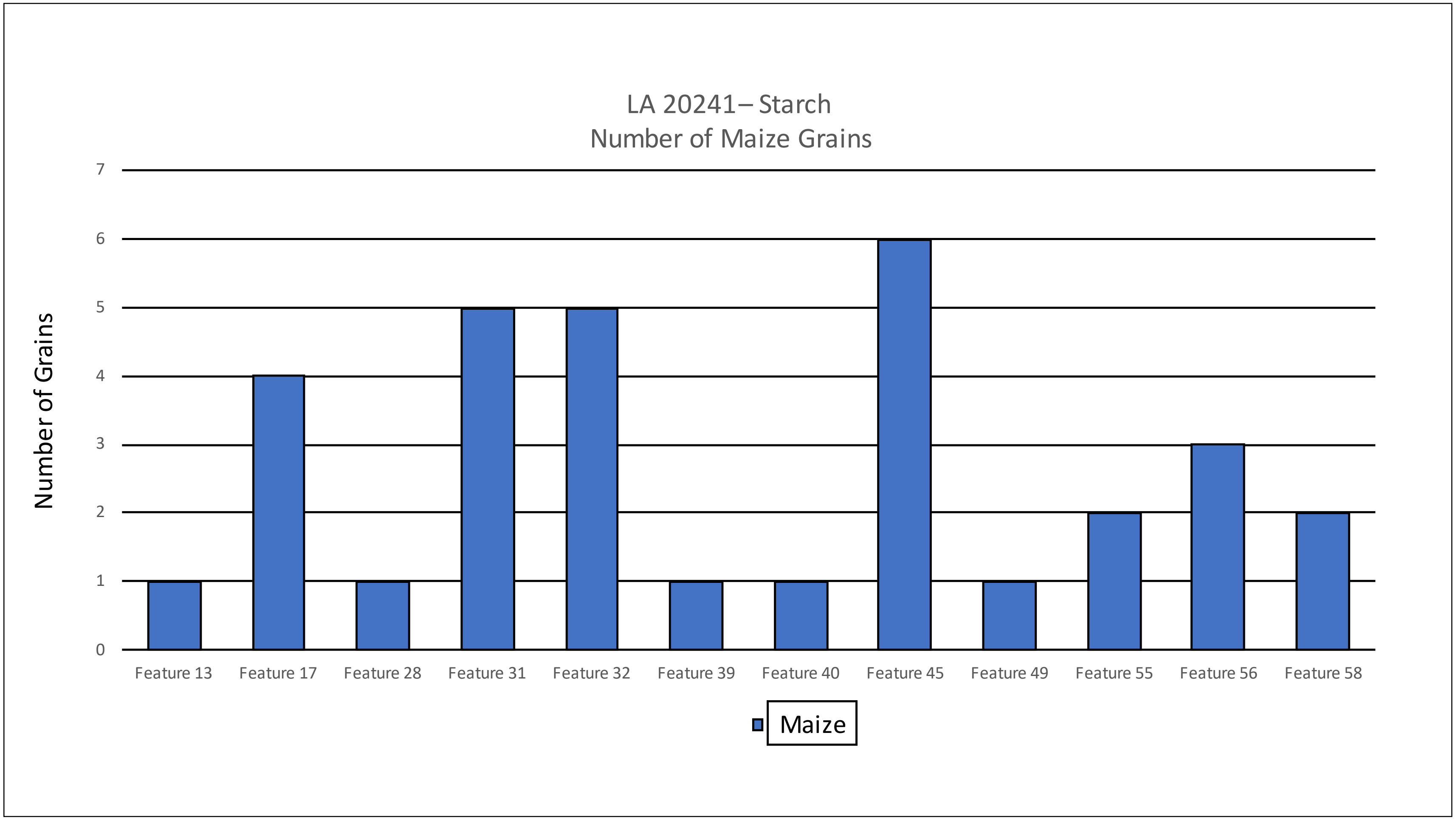


Figure 16- Site LA 20241 Quantity of Maize Grains from Starch Particles per 25 ml of Sediment. Chart Credit: Author

LA 38597 – The types of cultural features represented at Site LA 38597 are listed in (Table *4*).In sum, 18 maize grains are identified (Figure 17**)** in four samples from Features (4, 11, 12 and 32) and five probable maize grains were recovered from four samples from Features (11, 24, 32 and 33) (Cleeland et al. 2022b). Additionally, two damaged maize grains were identified from Features 32 and Feature 33.

Table 4. Site LA 38597 Feature Types and Maize Grains

Feature Designation	**Type**	**Depth (cmbs)**	**Number of Maize Grains/Probable Maize Grains**
4	Fire-cracked rock concentration	18–51	2/0
11	Fire-cracked rock concentration	80–87	3/ 2
12	Fire-cracked rock concentration	55–78	2/0
24	Thermal Stain	68–73	0/1
32	Fire-cracked rock concentration	50–55	11/1
33	Stain with fire-cracked rock concentration	25–30	0/1

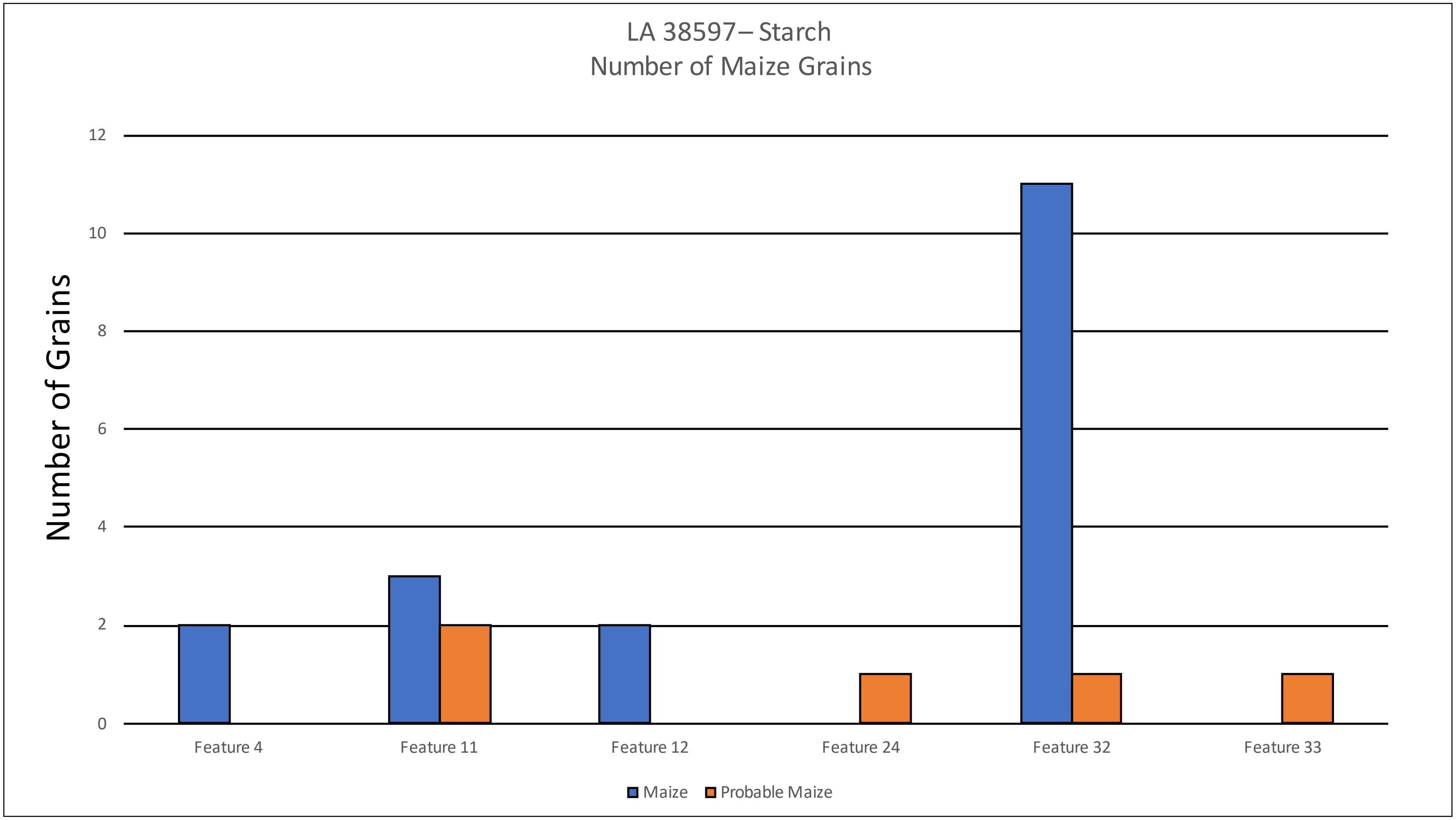


Figure 17- Site LA 38597 Quantity of Maize Grains from Starch Particles per 25 ml of Sediment. Chart Credit: Author

LA 112766 - The types of cultural features represented at Site LA 112766 are listed in Table 5 Maize dominated the assemblage in 10 features. In sum, 27 maize grains (Figure 18) were recovered in nine samples from Features 1, 5, 6, 7, 12, 15, 16, 17, 20 and 22 (Goar et al. 2022). Four samples from Features 1, 5, 12, and 17 yielded four grains of probable maize.

Table 5. Site LA 112766 Feature Types and Maize Grains

Feature Designation	Feature Type	Depth (cmbd)	Number of Maize Grains/Probable Maize Grains
1	Burnt Caliche Concentration	38–43	0/1
5	Hearth	125–135	4/0
6	Thermal Stain	72–82	2/0
7	Hearth	100–110	2/0
12	Hearth	110–120	3/1
15	Hearth	65–75	7/0
16	Hearth	90–100	4/0
17	Hearth	40–50	1/1
20	Hearth	70–80	3/0
22	Hearth	?	1/1

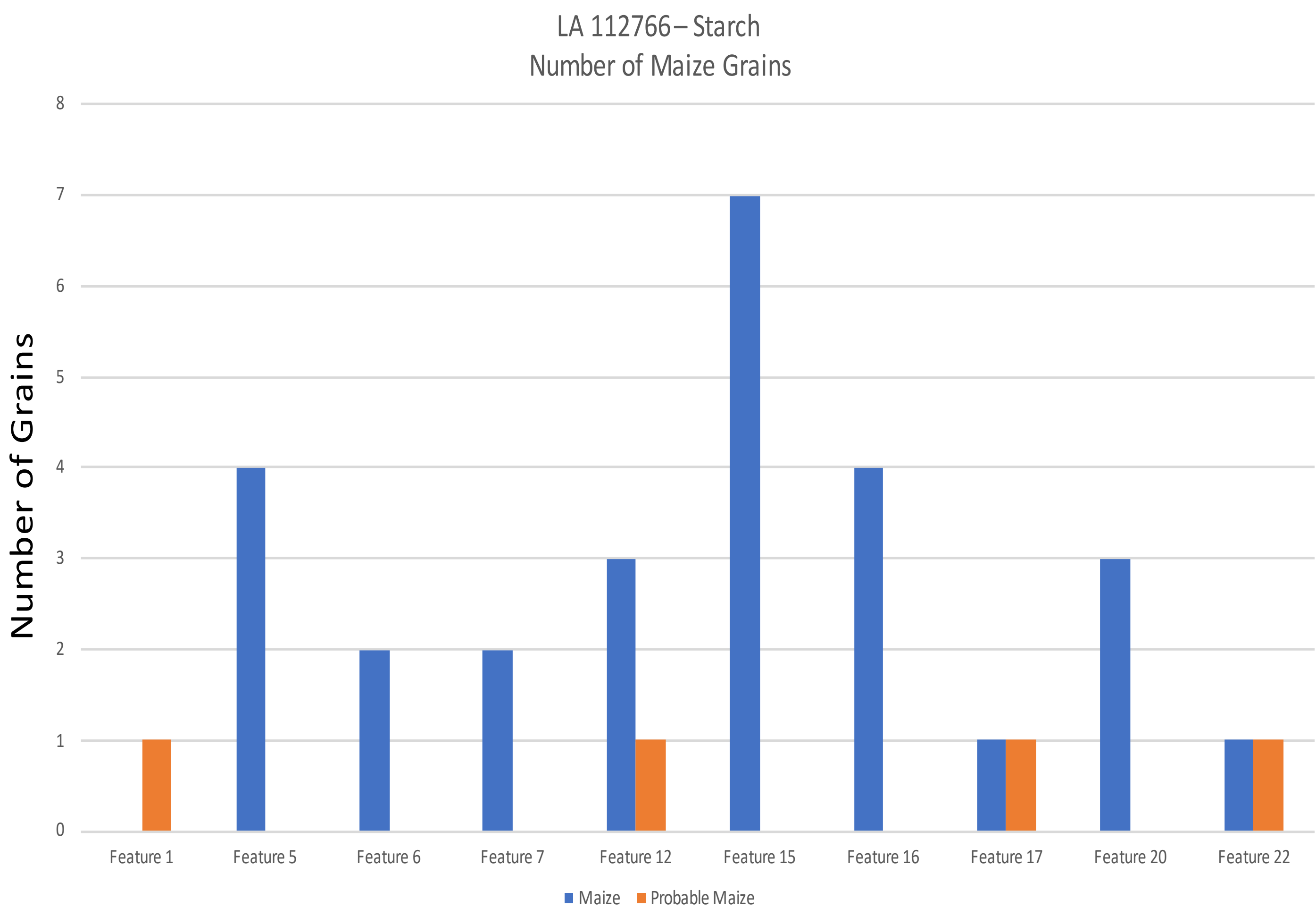


Figure 18- Site LA 112766 Quantity of Maize Grain from Starch Particles Per 25 ml of Sediment.
Chart Credit: Author

LA 131202 - The types of cultural features represented at Site LA 131202 are listed in Table 6. A total of 7 maize grains (Figure 19) were recovered from the 5 sediment samples. Feature 1 contained six maize grains, Feature 2 contained one probable maize grain. The histogram includes the starch results and the phytolith maize cupule found in feature 3.

Table 6. Site LA 131202 Feature Types and Maize Grains

Feature Designation	Feature Type	Depth (cmbd)	Number of Maize Grains/Probable Maize rains
1	Thermal Stain	100–110	6/1
2	Thermal Stain	110–120	0/1

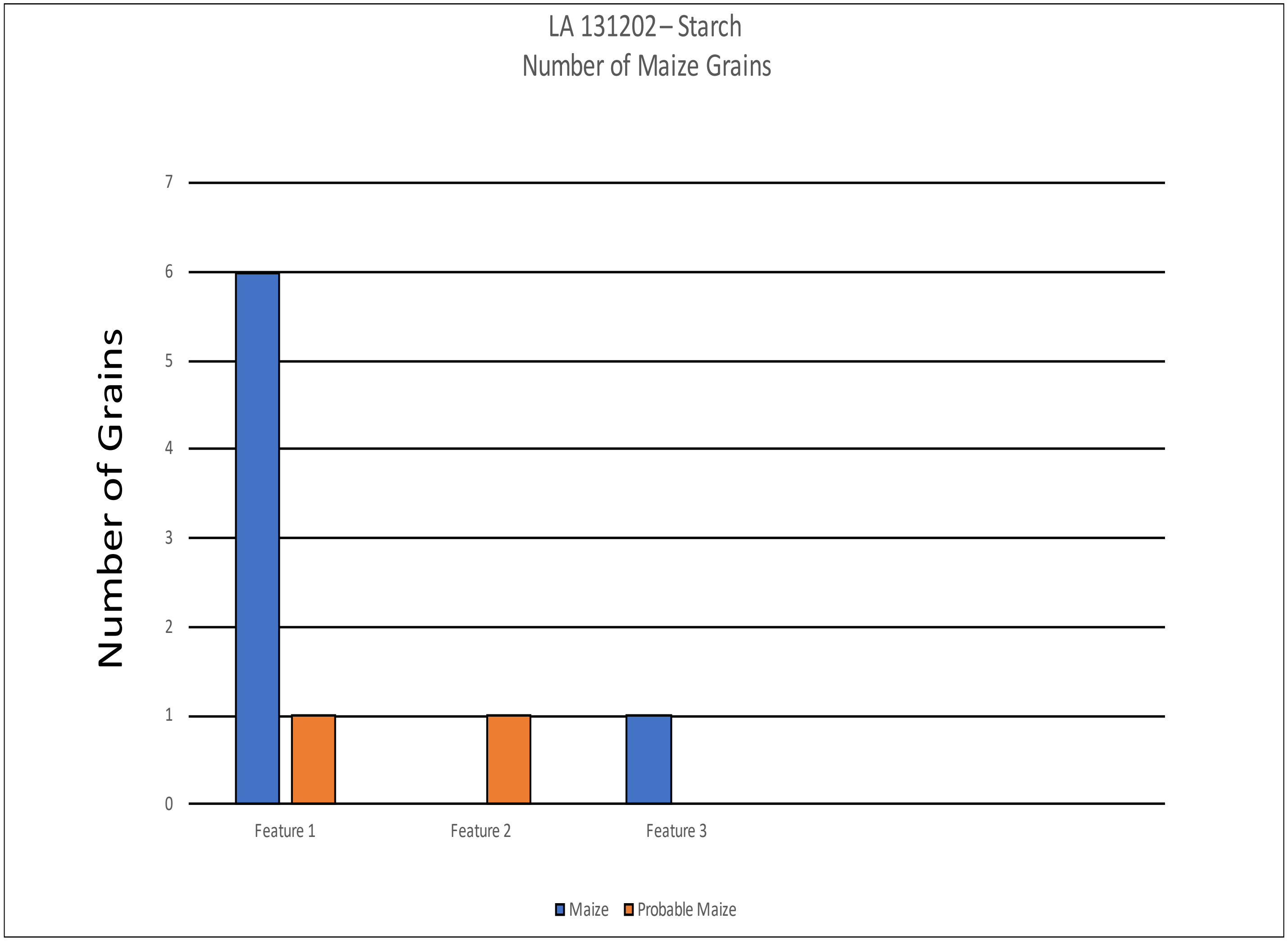


Figure 19- Site LA 131202 Quantity of Maize grains from Starch Particles Per 25 ml Sediment.
Chart Credit: Author

Radiocarbon Dataset

Radiocarbon dating was performed by Beta Analytic, Miami, Florida. Radiocarbon dates are presented using tables that include the cultural feature designation, the two-sigma calibrated date range in BC/AD, the calibrated Before Present (BP) date range, and the sample provenience. Box and Whisker graphs are presented for each site to visualize maize-containing features by date and clustering.

LA 20241 - Ten radiocarbon dates were reviewed from Site LA 20241. The dates and corresponding data are listed in Table 7 and presented in Figure 20. Organics were obtained through flotation of soil samples collected from features. Dated organics consist of wood charcoal. No macrobotanicals (i.e., cob fragments or cupules) were recovered from soil samples.

Table 7. Site LA 20241 Two Sigma Calibrated Radiocarbon Dates

Feature Designation	Date	Before Present	Provenience (Centimeters Below Surface)	Flotation
F13	AD 660– AD 774	1290–1176 BP	53–67	X
F17	AD 260–AD 534	1690–1416 BP	40–53	X
F28	AD 992–AD 1154	958–796 BP	75–85	X
F31	AD 576–AD 654	1374–1296 BP	115–125	X
F32	41 BC–AD 124	1990–1826 BP	35–40	X
F39	AD 432–AD 674	1518–1276 BP	105–118	X
F40	AD 1035–AD 1210	915–740 BP	70–80	X
F49	AD 1278–AD 1394	672–556 BP	60–65	X
F55	AD 63–AD 225	1887–1725 BP	11–28	X
F58	AD 604–AD 773	1346–1177 BP	15–25	X

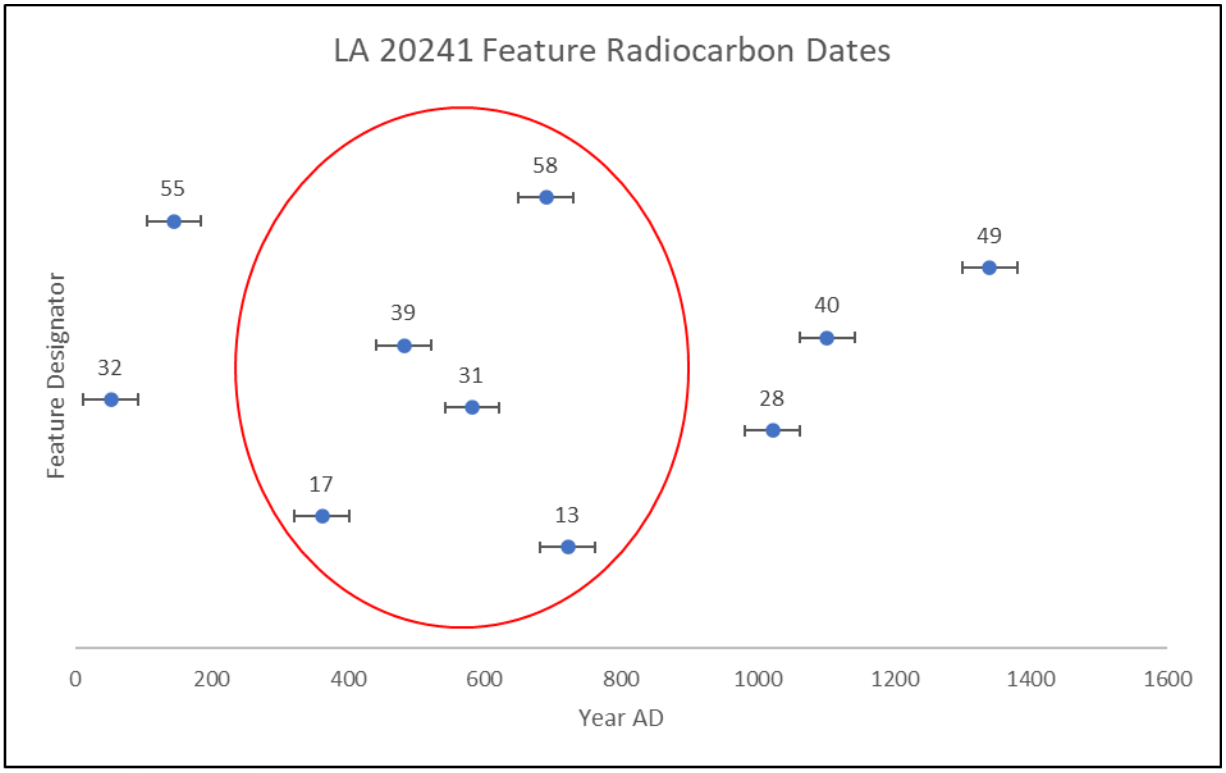


Figure 20- Site LA 20241 Radiocarbon Dates with Date Cluster Circled in Red.
Chart Credit: Author

LA 38597 - Of the six features containing evidence of maize, three contained charred material that could be radiocarbon dated. Three radiocarbon dates were reviewed and the dates, and corresponding data are listed in Table 8 and presented in Figure 21. Organics were obtained through flotation, on-site collection, and/or screening of soil samples collected from features. Dated organics consist of wood charcoal. No macrobotanicals (i.e., cob fragments or cupules) were recovered from the soil samples.

Two sediment samples derived from Feature 32 were sent for radiocarbon dating. The sample from Feature 32 that contained maize was collected from 50–55 centimeters below surface (cmbs) and dated to AD 640–AD 774.

Two sediment samples derived from Feature 33 were sent for radiocarbon dating. The sample from Feature 33, that contained maize, was collected from 20–25 cmbs and dated to 2460–2206 BC.

Table 8 Site LA 38597 Two Sigma Calibrated Radiocarbon Dates

Feature Designation	Date	Before Present	Provenience (Centimeters Below Surface)	Flotation	Collected on Site	Screened
F24	AD 382–AD 542	1568–1408 BP	58–63 63–68 68–73	X		
F32	2287–2041 BC, AD 640–AD 774	4188–4042 BP 1176–1310 BP	55–60 50–55	X		X
F33	2460–2206 BC, AD 640–774	4409–4155 BP 1176–1310 BP	20–25 15–20	X	X	

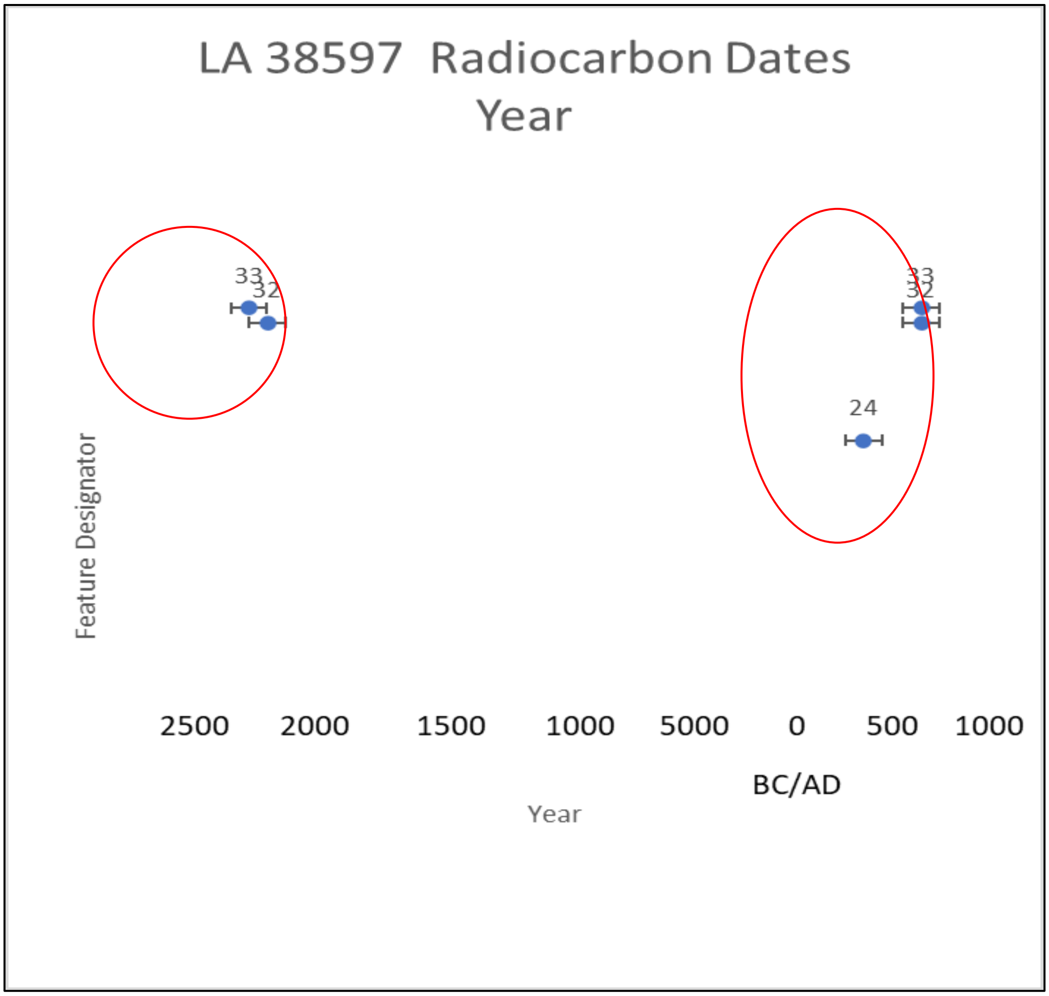


Figure 21- Site LA 38597 Radiocarbon Dates with Date Cluster Circled in Red.
Chart Credit: Author

LA 112766 - Of the ten features containing evidence of maize, five contained charred material that could be radiocarbon dated. Five radiocarbon dates were reviewed, and the dates and corresponding data are listed in; and presented in Table 9 Organics were obtained through flotation of soil samples collected from features. Dated organics consist of wood charcoal. No macrobotanicals (i.e., cob fragments or cupules) were recovered from soil samples.

Table 9. Site LA 112766 Two Sigma Calibrated Radiocarbon Dates

Feature Designation	Date	Before Present	Provenience (cmbd)	Flotation
F5	2876–2626 BC	4825–4575 BP	125–135	X
F6	AD 130–AD 326	1820–1624 BP	72–82	X
F7	AD 663–AD 866	1287–1084 BP	100–110	X
F15	AD 686–AD 888	1264–1062 BP	65–75	X
F17	AD 770–Ad 972	1180–978 BP	110–120	X

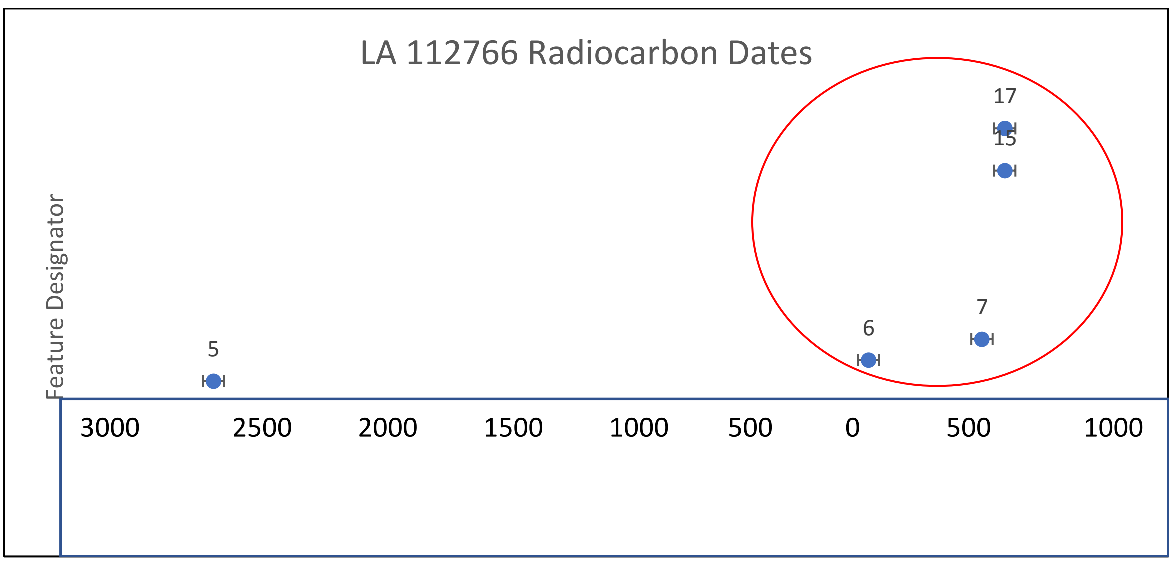


Figure 22- LA 112766 Radiocarbon Dates with Date Cluster Circled in Red.
Chart Credit: Author

LA 131202 - Three radiocarbon dates were reviewed from Site LA 131202. The dates and corresponding data are listed in Table 10 and shown in Figure 23. Organics were obtained through flotation of soil samples collected from features. Dated organics consist of wood charcoal. A maize cupule was identified in Feature 3 during the macrobotanical analysis. The cupule was not charred and could not be dated.

Table 10 Site LA 131202 Two Sigma Calibrated Radiocarbon Dates

Feature Designation	Date	Before Present	Provenience (Centimeters Below Surface)	Flotation
F1	AD 673–AD 878	1327–1072 BP	100–110	X
F2	AD 896–AD 1114	1054–836 BP	110–120	X
F3	AD 776–AD 994	1174–776 BP	100–110	X

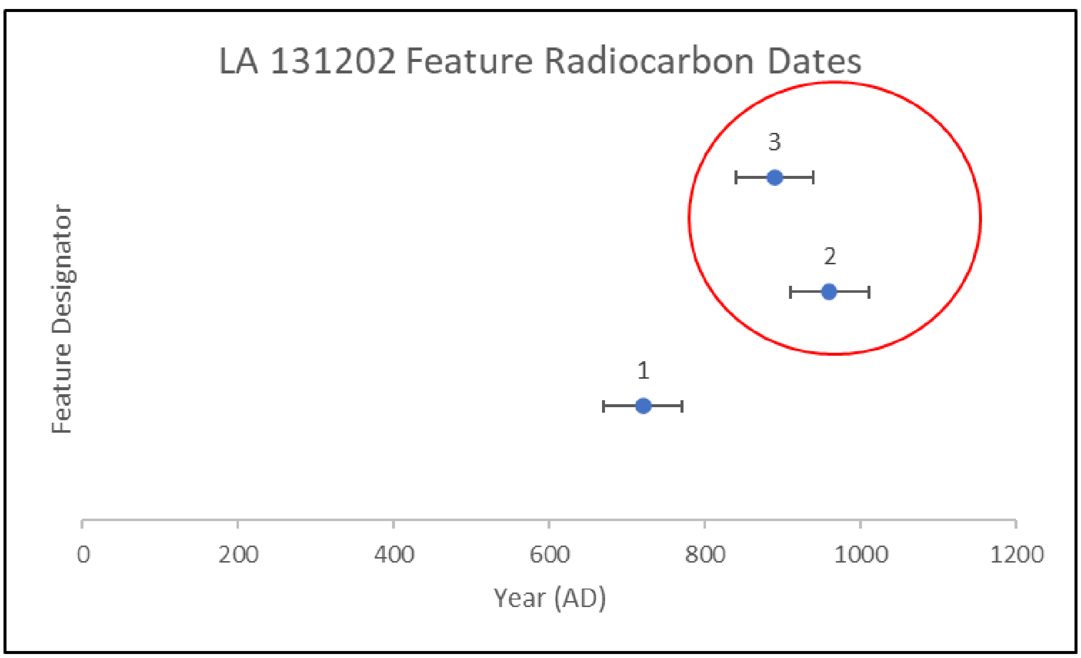


Figure 23- Site LA 131202 Radiocarbon Dates with Date Cluster Circled in Red.
Chart Credit: Author

Ceramic Dataset

Ceramic identification was conducted by Dr. Michael Marshall (Cleeland et al. 2022a, 2022b; Goar et al. 2022) and data is presented in tables for each case study site. Petrographic analysis was conducted by Dr. David Hill, Independent Contractor. Dr. Hill used the Wentworth scale (Figure 24) for size measurement The excavated portion of Site LA 131202 is aceramic.

Wentworth Scale (Scale in millimeters)
VC=Very Course 2.0–1.0
C=Course 1.0–0.50
M=Medium 0.50–0.25
F=Fine 0.25–0.125
VF=Very Fine 0.125–0.0625
ST=Below 0.0625

Figure 24- Wentworth Scale for Petrographic Analysis Scale
Adapted from Dr. David Hill 2022

LA 20241 - The ceramic assemblage collected from Site LA 20241 consists of six ceramic types (Table 11). Most of the assemblage (73.5%) is Jornada Group Plain Brownware. The analyzed ceramics are fragments and include: 36 jars, 12 bowls, and 5 sherds of unknown form (Cleeland et al. 2022a). Five ceramic samples were sent for petrographic analysis (Table 12). No ceramics were recovered from cultural features with maize residue.

Table 11. Site LA 20241 Ceramics. (Marshall 2022)

Type	Date Range	Percent	Count
Jornada Group Plain brownware	AD 500–AD 1100	73.5	39
Jornada Group Red-slipped brownware	AD 700–AD 1350	5.7	3
Jornada Group Black-on-brown	AD 700–AD 1350	1.9	1
Ochoa Corrugated brownware	AD 1300–AD 1450	11.3	6
Corona Corrugated (Capitan variety) brownware	AD 1300–AD 1450	5.7	3
Chupadero whiteware	AD 1050–AD 1550	1.9	1
Total		**100**	**53**

Table 12. Site LA 20241 Petrographic Results (Cleeland 2022)

Site	FS	Ceramic Type	Primary Inclusion	Amount	Size	Possible Origin
LA 20241	123	Brownware	Granite	15%	VC-F	El Paso, Texas Area
LA 20241	126	Corona Corrugated	Granite aplite	25%	VF-F	Lincoln County Porphyry Belt
LA 20241	149	Corona Corrugated	Granite aplite	25%	VF-F	Lincoln County Porphyry Belt
LA 20241	T77-1-2	Brownware	Granite	25%	M-VC	El Paso, Texas Area
LA 20241	116	Chupadero Black-on-White	Crushed potsherds	10%	M	Sierra Blanca Area

LA 38597 - The ceramic assemblage collected from Site LA 38597 consists of two ceramic types **(**Table 13**).** Most of the assemblage (99%) is Jornada Group Plain Brownware. Analyzed ceramics are fragments and include: 46 jars, 3 bowls, and 38 sherds of unknown form (Cleeland et al. 2022a). Two sherds were recovered from the surface of Feature 31, a non-maize feature, which is adjacent to two maize features (Feature 32 and Feature 33). Two ceramic samples were sent for Petrographic analysis (Table 14).

Table 13. Site LA 38597 Ceramics (Marshall 2022)

Type	Date Range	Percent	Count
Jornada Group Plain brownware	AD 500–AD 1100	99	86
Unidentified brownware plain (fine sand temper)	AD 500–AD 1100	1	1
Total		**100**	**87**

Table 14. Site LA 38597 Petrographic Results (Cleeland 2022)

Site	FS	Ceramic Type	Primary Inclusion	Amount	Size	Possible Origin
LA 38597	136	Brownware	Granite	15%	VF-VC	Lincoln County Porphyry Belt
LA 38597	237-B	Brownware	Granite	25%	VF-VC	Lincoln County Porphyry Belt

LA 112766 - The ceramic assemblage collected from Site LA 112766 consists of three ceramic types (Table *15*). Most of the assemblage (98%) is Jornada Group Plain Brownware. All ceramics analyzed are fragments and include: 1 jar, and 4 sherds of unknown form (Goar et al. 2022). One ceramic sample was sent for Petrographic analysis (Table 16). No ceramics were in any of the cultural features.

Table 15. Site LA 112766 Ceramics. (Marshall 2022)

Type	Date Range	Percent	Count
Jornada Group Plain brownware	AD 500–AD 1100	98	3
El Paso Plain Brown	AD 200–AD400	1	1
El Paso Polychrome	AD 1250–AD 1450	1	1
Total		**100**	**5**

Table 16. Site LA 112766 Petrographic Results (Goar 2022)

Site	FS	Ceramic Type	Primary Inclusion	Amount	Size	Possible Origin
LA 112665	85-2	Brownware	Quartz monzonite	15%	VF-M	Lincoln County Porphyry Belt

Site Cultural Feature Summaries

LA 20241 - Summary

Of the 12 cultural features determined to contain maize: two did not contain charred remains and could not be radiocarbon dated, six features (Features 17, 32, 39, 49, 56 and 58) radiocarbon dated to the Late Archaic period, four features (Features 13, 28, 31, and 40) radiocarbon date to the Early Formative period, Feature 49 dates to the Late Formative (Goar et al.2022). Associated cultural materials include a complete metate recovered from Feature 32 (Figure 25).

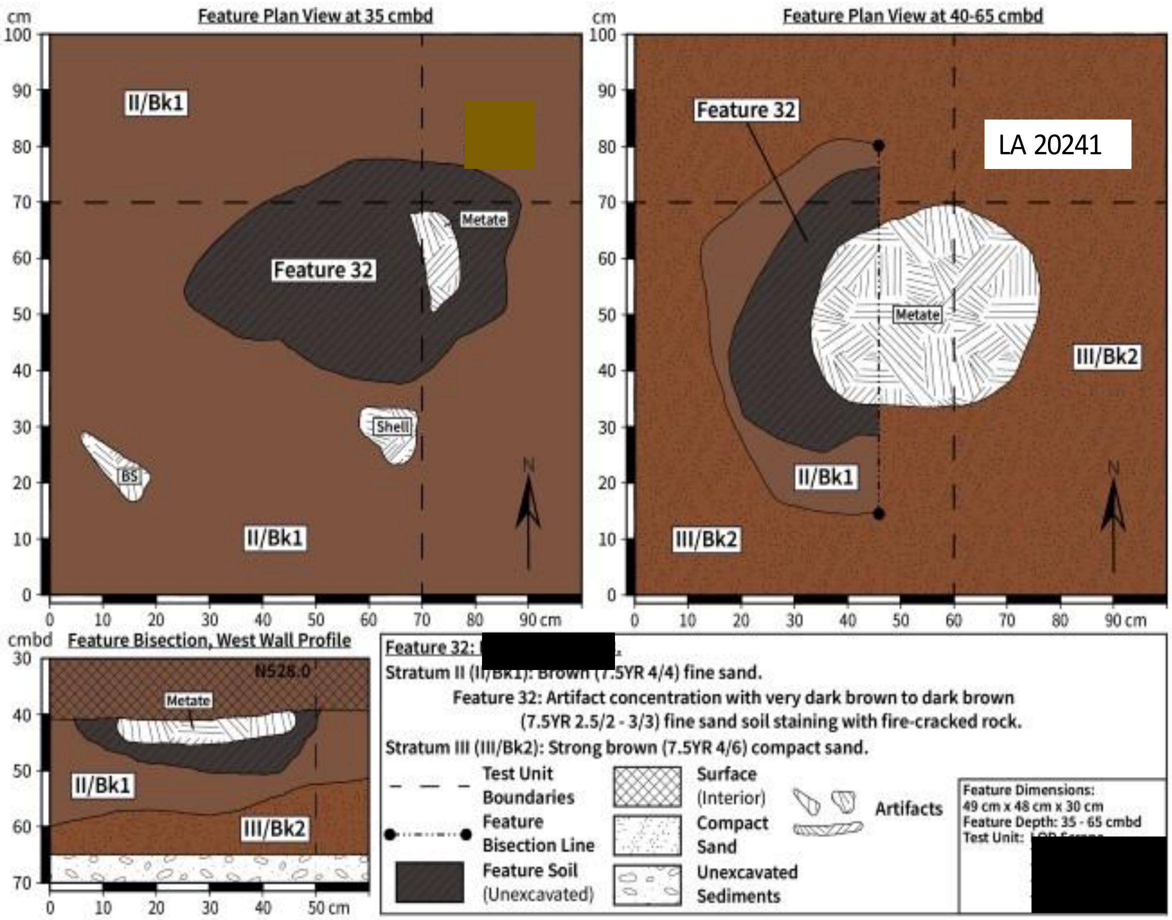


Figure 25- Site LA 20241 Feature 32
Map Credit: Cleeland et al. 2022

LA 38597 - Summary

Of the six features determined to contain maize, three features (4, 11, and 12) could not be radiocarbon dated, two features (Features 32 and 33) radiocarbon date to both the Middle Archaic period and to the Early Formative period, one feature (Feature 24) radiocarbon dates to the Late Archaic period (Cleeland et al. 2022)

Feature 32 (Figure 26) is a fire-cracked rock concentration that contained 56% of the maize grains identified on the site. Two sediment samples from Feature 32 were sent for radiocarbon dating. The sample from Feature 32, that contained maize, was collected from 50–55 cmbs and dates to AD 640–AD 774; an Early Formative period date. The second sample was recovered from 55–60 cmbs and dates to 2287–2040 BC; a Middle Archaic period date. The Early Formative date is likely the correct date for maize at Feature 32. The Feature 32 Middle Archaic sample was radiocarbon dated; however, macrobotanical, phytolith and/or starch analyses were not conducted. It is possible that superimposition may have occurred and an Early Formative feature intruded on a Middle Archaic feature. The determination of maize present during the Middle Archaic is inconclusive.

Feature 33 (Figure 27) is a thermal stain with a fire-cracked rock concentration. Two sediment samples from Feature 33 were sent for radiocarbon dating. The sample from Feature 33, that contained maize, was collected from 20–25 cmbs and dates to 2460–2206 BC, a Middle Archaic period date. The second sample was collected from 15–20 cmbs and dated to AD 640–AD 774, an Early Formative period date. The Middle Archaic sample, from Feature 33 was radiocarbon dated; however, macrobotanical, phytolith and/or starch analysis was not conducted for this sample. Starch and the radiocarbon date for the Middle Archaic sample indicate that maize was present during the Middle Archaic however, the anomaly present in Feature 32 presents the possibility of superimposition occurring at Feature 33. The determination of Middle Archaic maize at Site LA 38597 remains inconclusive.

Site LA 38597 has no evidence of storage pit features. All recovered ceramics are Plain Brownware dating to the Early Formative Period. The Middle Archaic Period is aceramic in southeast New Mexico. Associated cultural materials in Feature 32 include a mano, groundstone fragments, and lithic debitage.

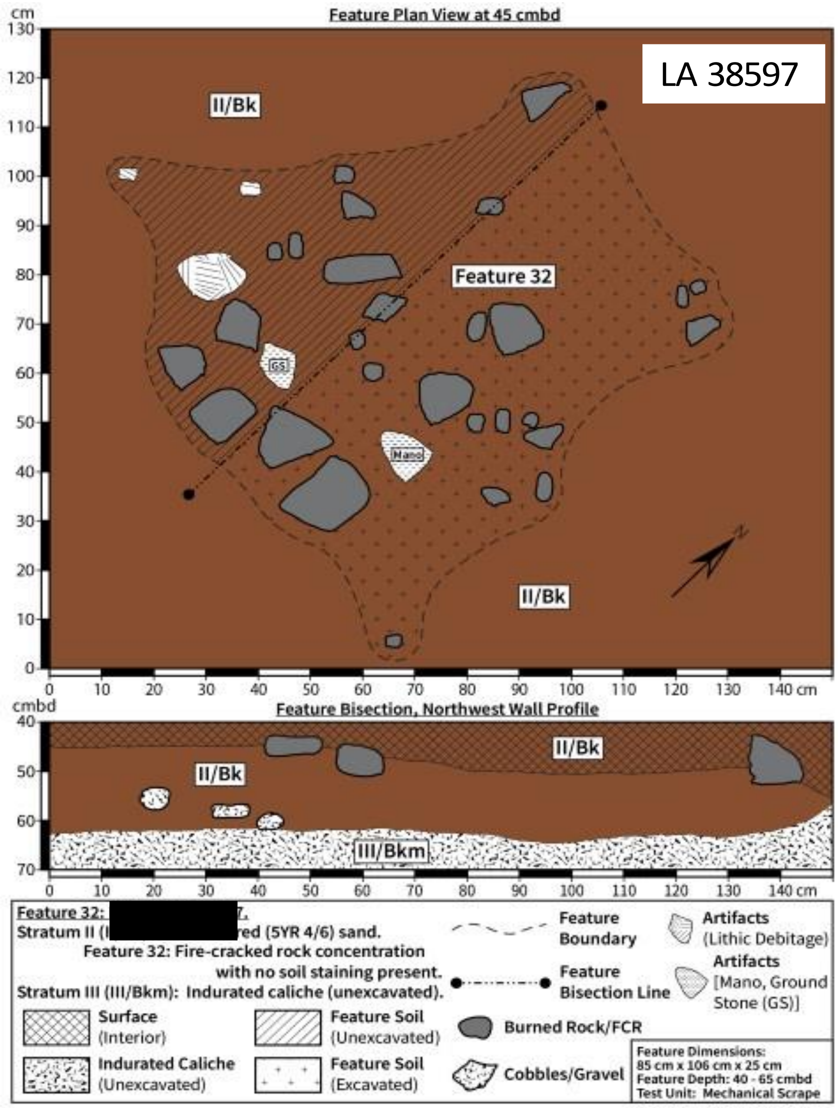


Figure 26- Site LA 38597 Feature 32
Map Credit: Cleeland et al; *2022*

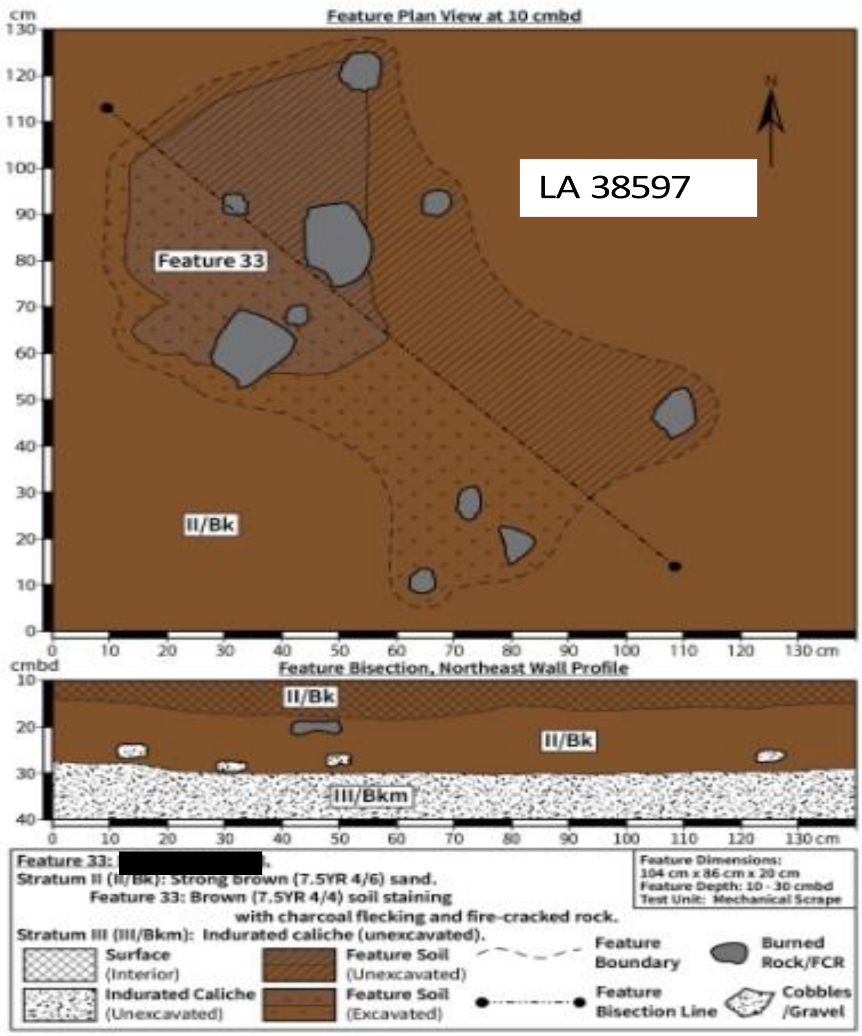


Figure 27- Site LA 38597 Feature 33
Map Credit: Cleeland et al. 2022

LA 112766 - Summary

Of the ten features determined to contain maize, five features 1, 16, 17, 20 and 22 could not be radiocarbon dated, Feature 5 radiocarbon dated to the Middle Archaic period, Feature 6 radiocarbon dated to the Late Archaic period, three features (7, 12, and 15) radiocarbon dated to the Early Formative period (Goar 2022).

Feature 5 radiocarbon dated to 2876–2626 BC, indicating the presence of maize during the Middle Archaic period in southeast New Mexico. Feature 5 contained both phytolith and starch evidence of maize. The feature is a burnt caliche concentration that contained 11% of all maize identified within the collection. This evidence supports the hypothesis that early maize was present in southeastern New Mexico.

Geomorphological analysis and OSL dating, conducted by Jill Onken Independent Consultant provide additional evidence for Middle Archaic maize at Site 112766 (Goar et al. 2022). Personal communication, Ms. Onken expressed the significance and indication of four maize starch grains in Feature 5. The calibrated radiocarbon age of the feature (4825–4575 BP). The radiocarbon date is reinforced by an OSL daye of 4060+/-220 years on eolian sand 10 cm above the feature. Figure 28 is an oxcal graph, provided by Ms. Onken, illustrating the OSL dates and radiocarbon dates within mechanical trench 6, where feature 5 was identified. Both the OSL date and the radiocarbon date, suggest very early maize in southeastern New Mexico on par with the oldest known maize sites (i.e., Old Corn Site and Las Capas) in southwestern United States. Ms. Onken, does emphasize that the argument, for early maize in southeast New Mexico, would be stronger if the radiocarbon-dated material was a maize macrofossil (i.e., cupule or cobb) and not just charcoal-stained sediment from the feature. Additionally, Ms. Onken mentions that a skeptic could argue that the maize may be intrusive; however, the number of starch grains and deep stratigraphic context (130 cmbs) approximately a meter below the expected context of the predominantly Early Formative occupation of the site suggest that intrusion is less likely. Yet, the radiocarbon date and OSL date are a data point that may prove to be part of a larger pattern with time.

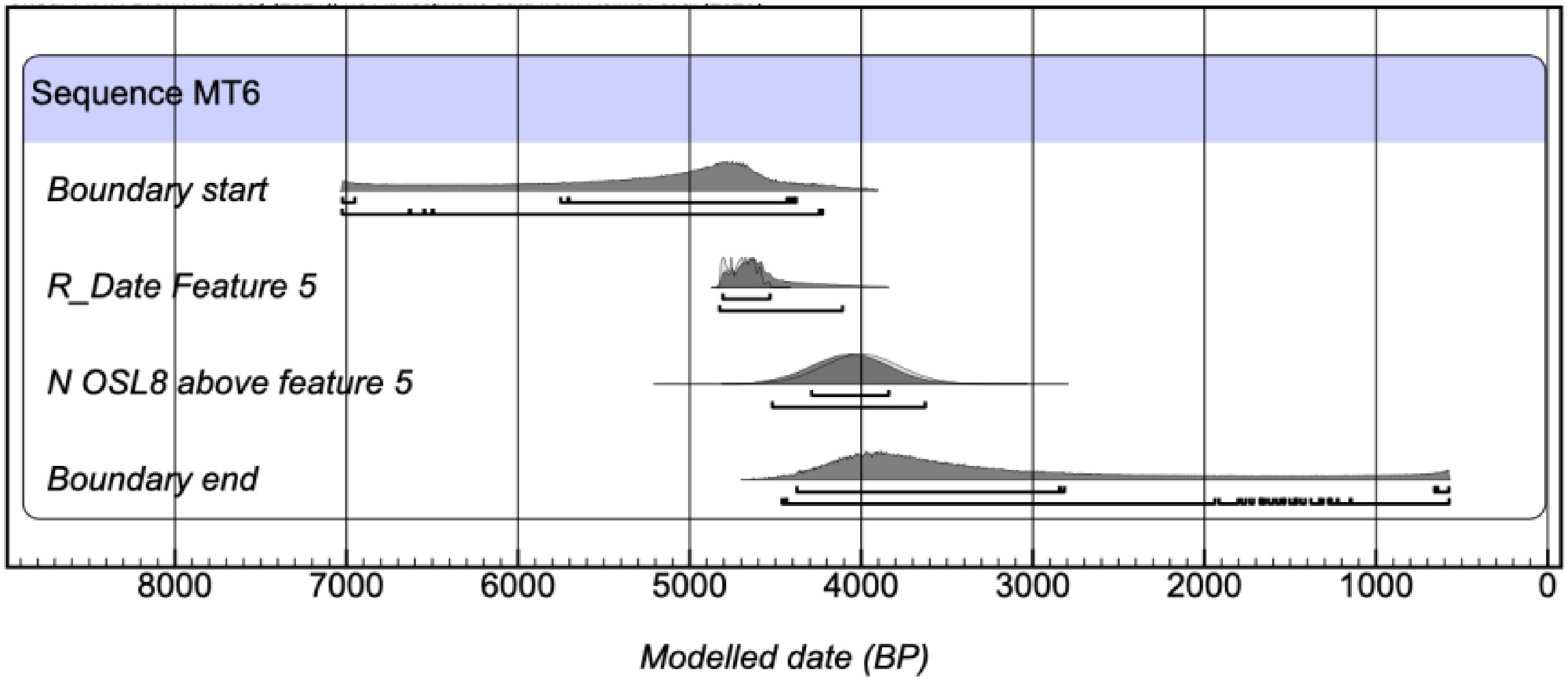


Figure 28- Site LA 112766 Geomorphology OSL Model
Graphic Credit: Goar et al; 2022

LA 131202 - Summary

The excavated cultural features on Site LA 131202, radiocarbon date to the Early Formative period but no ceramics were recovered from the excavated portion of the site. Site LA 131202 is the only site that contained a maize cupule (Goar et al. 2022).

Maize Site Literature Review Dataset

Table 17 lists 33 previously recorded archaeological sites in southeastern New Mexico that have macrobotanical, starch, FTIR, or phytolith evidence of maize. These previous sites are placed on maps in their geographical location alongside the case study sites. Analysis of cultural period, distance between sites, distance between site and water source, and maize dates were used to locate any patterns that provide insight to answer the question of when and to what extent maize was integrated into the subsistence of southeastern New Mexico prehistoric groups. In addition, a comparison of southeastern New Mexico old maize sites was completed. This dataset provides the evidence needed to develop a multi-point image of prehistoric cultures and the subsistence patterns in southeastern New Mexico during different occupations.

Table 17. Previously Recorded Maize Sites

Site	Site Date Range	Cultural Affiliation	Maize		Citation
			Macro	Micro/ Residue	
LA 3228	AD 1100-1450	Late Formative	X		Hunt 1989
LA 5148	AD 1100-1450	Late Formative		X (starch, poss. FTIR)	Brown 2010
LA 17041	AD 670-1400	Formative		X (poss. FTIR)	Condon et al 2008
LA 2000	AD 1100-1450	Late Formative	X		Jennings 1940
LA 32901	AD 259-392	Late Archaic			Carlson 2018
LA 43414	AD 1300-1450	Late Formative	X	X (phytoliths and pollen)	Cumming and Kovacik 2013
LA 49917	1500 BC-200 AD	Late Archaic		X (starch)	Condon et al 2008
LA 58971	AD 1-450	Late Archaic			SWCA 2001
LA 64498	AD 500-1100	Early Formative		X (phytoliths)	Cumming and Kovacik 2013
LA 68182	300 BC-AD 1	Late Archaic			Ensey 2004
LA 75431	AD 900-1350	Formative		X (phytoliths)	Cumming and Kovacik 2013
LA 77971	AD 1100-1400	Late Formative		X (phytoliths)	Cumming and Kovacik 2013
LA 99434	AD 540-650	Early Formative		X (FTIR)	Boggess 2009
LA 99436	AD 200-1400	Late Archaic/Early Formative		X (phytoliths)	Cumming and Kovacik 2013
LA 103523	AD 70-320	Late Formative	X		Cumming and Kovacik 2013
LA 104393	AD 650-1050	Early Formative		X (phytoliths)	Cumming and Kovacik 2013
LA 104607	AD 1000-1100	Late Formative	X		Clifton 1994
LA 120945	AD 900-1400	Early Formative		X (phytoliths)	Cumming and Kovacik 2013
LA 135210	1800 BC-AD 1100	Late Archaic Early Formative		X (starch)	Brown and Brown 2011
LA 135212	1800 BC-AD 1100	Late Archaic/ Early Formative		X (starch)	Brown and Brown 2011
LA 135213	AD 1-500	Late Archaic		X (starch)	Brown and Brown 2011
LA 135222	?	?		X (starch)	Brown and Brown 2011
LA 140914	AD 900-1350	Formative			Cumming and Kovacik 2013
LA 143755	AD 340-920	Early Formative		X (starch, poss. Phytoliths)	Railey 2011
LA 146443	AD 673-704	Early Formative			Ensey 2004
LA 149260	1600 BC-AD 200	Late Archaic/		X (FTIR)	Boggess 2010

Site	Site Date Range	Cultural Affiliation	Maize		Citation
			Macro	Micro/ Residue	
		Early Formative			
LA 149279	1800 BC-200 AD	Late Archaic		X (poss. Starch)	Boggess 2010a
LA 149787	AD 500-1100	Early Formative			Cumming and Kovacik 2013
LA 155571	AD 1150-1450	Late Formative		X (starch)	Brown and Brown 2011
LA 169041	AD 500-1100	Early Formative		X (phytoliths)	Ensey 2004
LA 170924	AD 400-1300	Formative		X (phytoliths)	Cumming and Kovacik 2013
LA 172564	AD 1450-1880	Late Formative		X (phytoliths)	Cumming and Kovacik 2013
LA 177527	AD 200-1400	Late Archaic/Late Formative		X (Starch, poss. phytoliths)	Anderson and Brown 2016

Figure 29 and Table 18 contain a compilation of the case study sites and the previously recorded maize sites. Each site on the map is assigned a color denoting the cultural period association on the site. Figure 29 is a 50 mi aspect depicting the cluster of maize sites and outliers. Figure 30 is a 10 mi aspect narrowed in on the site cluster. An analysis of existing patterns, anomalies, and distances within the dataset was completed to determine the existence and movement of maize during specific time periods. Figure 31 illustrates the case study sites geographical location in relation to the Pecos River, the nearest large water source. These maps encompass and organize the results of this literature review and are followed by a discussion of the findings.

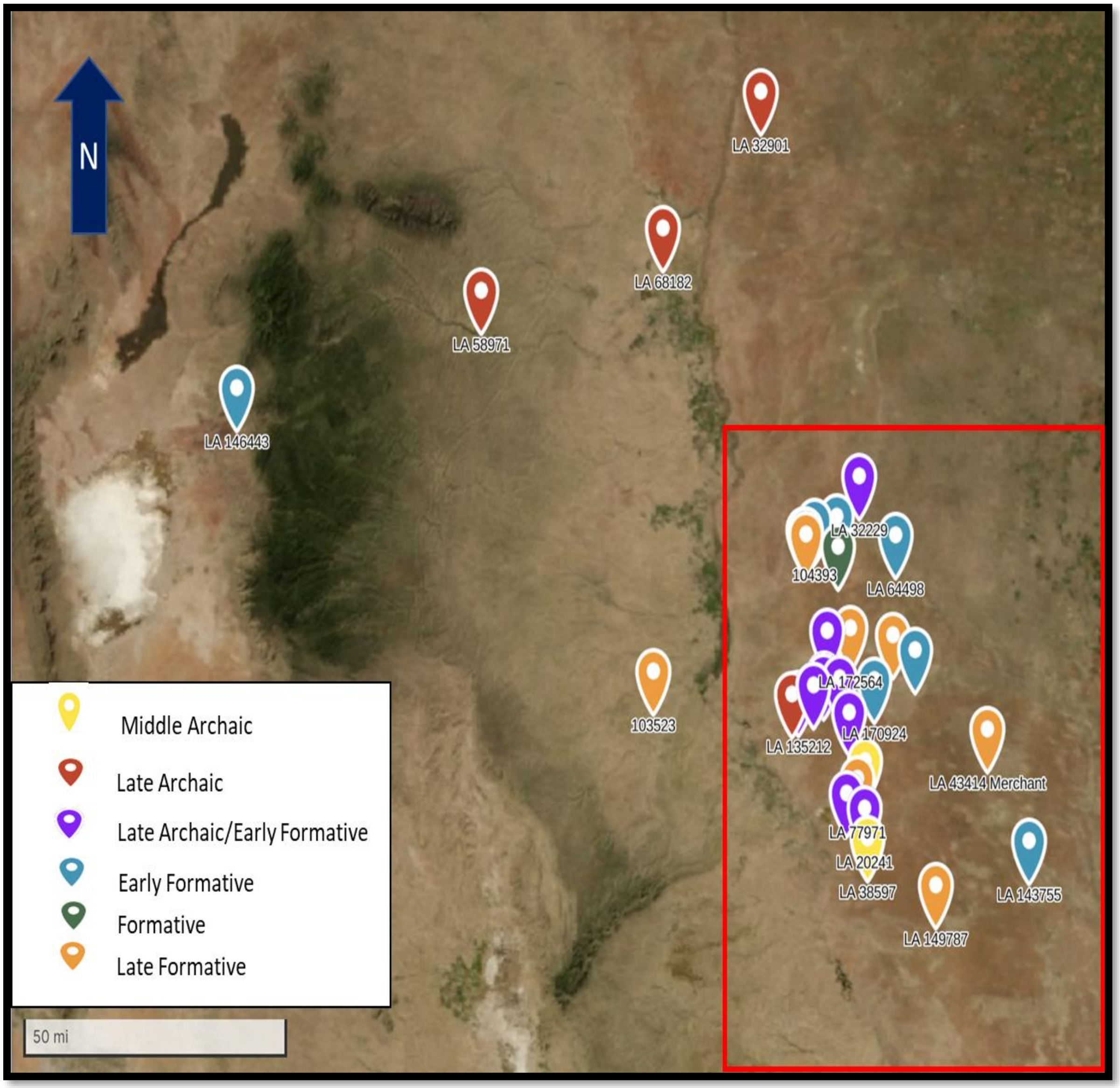


Figure 29- Case Study Sites in Relation to Previously Recorded Sites.
Map Credit: Author

Table 18. Number of Sites Affiliated with Cultural Periods.

Color Code	Earliest Cultural Occupation Period	Number of sites	Site Affiliation
	Middle Archaic	2	LA 38597, LA 112766
	Late Archaic	6	LA 32901, LA 49917, LA 58971, LA 68182, LA 135213, LA 149279
	Late Archaic/Early Formative	7	LA 20241, LA 99436, LA 131202, LA135210, LA 135212, LA 149260, LA 177527
	Early Formative	8	LA 64498, LA 99434, LA 104393, LA120945, LA 143755, LA 146443, LA 149787, LA169041
	Formative	4	LA 17041, LA 75431, LA 140914, LA 170924
	Late Formative	9	LA 3228, LA5148, LA 2000, LA 43414, LA 77971, LA 103523, LA 104607, LA 155571, LA 172564

Table 18 shows the distribution of sites according to the Cultural Occupation Period defined by radiocarbon dating conducted at each site. An analysis of these numbers reveals any population increase or decrease occurring over time. The placement of each site, along with its temporal affiliation, indicate the movement of prehistoric peoples across the landscape. It explains the when and where of cultural occupation.

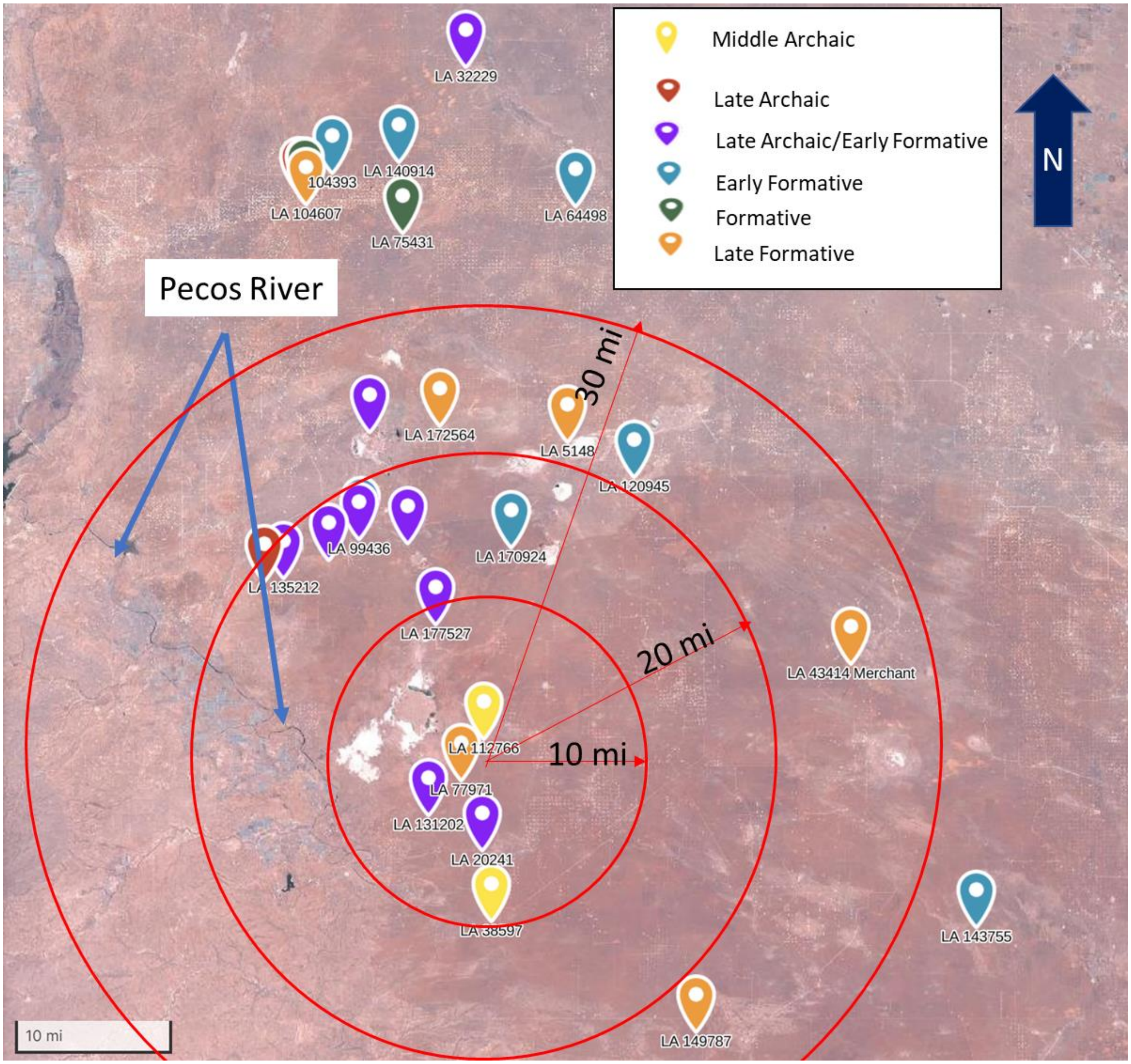
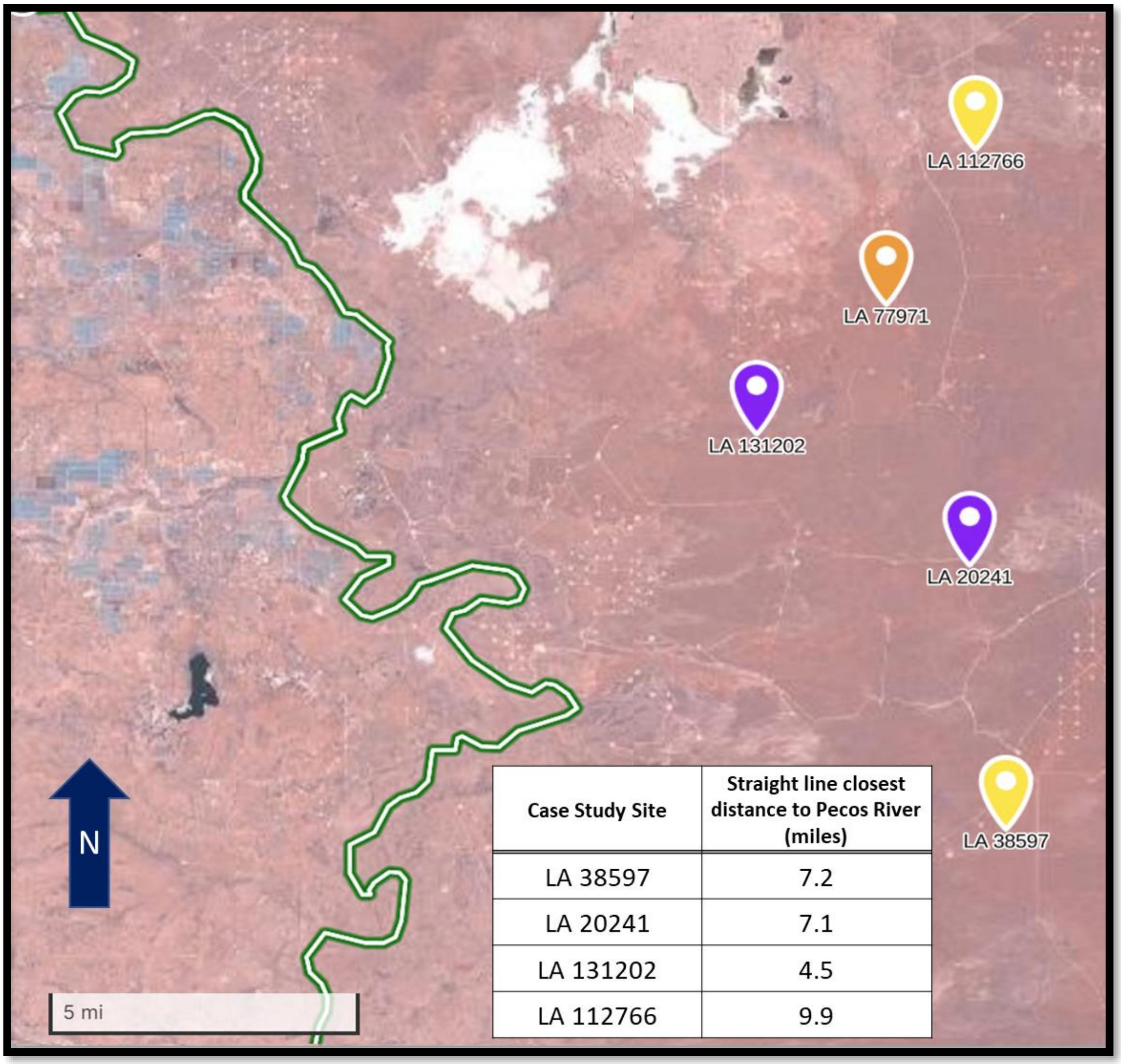


Figure 30- Case Study and Previously Recorded Maize Sites - 10 mi Aspect.
Map Credit: Author



Case Study Site	Straight line closest distance to Pecos River (miles)
LA 38597	7.2
LA 20241	7.1
LA 131202	4.5
LA 112766	9.9

Figure 31- Case Study Sites Distance to Pecos River.
Map Credit: Author.

<u>Terrestrial Occupation Patterns</u>

Reviewing the maize site maps, patterns of occupation become evident. Two of the case study sites are the only Middle Archaic sites in the study and are located on the southern edge of a larger cluster of Late Archaic/Early Formative sites. The Late Archaic/Early Formative sites form a linear north/south occupation swath along the Pecos River. The date range and the higher percentage of Late Archaic/Early Formative sites indicate that a larger population was present, in southeastern New Mexico, and that these sites were repeatedly occupied. The Late Archaic period sites are outliers located to the north and trend in a southwest/northwest linear pattern along the Pecos River and one of its tributary branches. These sites, unlike the Late Archaic/Early Formative period sites that were reoccupied, these outliers were not inhabited after the Late Archaic period. What environmental pressure caused the prehistoric groups to prefer the landscape 70 miles to the south?

Temporal Occupation Patterns

The pattern of temporal use on the landscape indicates that over time, as populations increased (Table 18), not only did the number of sites increase but they also began to group together in a smaller radius during the Late Archaic/Early Formative period (See Figure 30) and then begin to spread out during later occupation periods. Could this be an indicator of Nuclear Zones being established within the Marginal Zone creating new marginal zones to the east farther away from water resources?

An interesting temporal anomaly in the results from this investigation is that the Middle Archaic period features examined contained a much higher quantity (1:6) of maize grains per feature than the Late Archaic/Early Formative period sites. Why was there less maize present during this time?

Chapter 6 – Synthesis

Analysis of macrobotanical, phytolith, starch, radiocarbon dating, and ceramic datasets from Sites LA 20241, LA 38597, LA 112766 and LA 131202 provide evidence that aid in answering the thesis question – When and to what extent was maize integrated into the subsistence of prehistoric groups of the Permian Basin of southeastern New Mexico?

When was maize integrated into the subsistence of prehistoric groups of the Permian Basin of southeastern New Mexico?

The oldest maize site closest to the case study sites is Keystone Dam (Figure 3) radiocarbon dated to 3540 BP (O'Laughlin 1980). Keystone Dam is on the Texas side of the Texas/New Mexico border. Maize evidence from two of the case study sites, LA 38597 (inconclusive) and Site LA 112766, provide radiocarbon dates indicating maize earlier than any of the previously known maize sites listed in the maize data set. LA 112766 contains one cultural feature with radiocarbon dates, and phytolith and starch, evidence of maize earlier than Keystone Dam. Feature 5 radio carbon dates 4825–4575 BP. Multiple lines of evidence suggests that maize was present on LA 112766 approximately 500–1,000 years prior to any previously recorded maize site in our study in southeastern New Mexico.

There is no evidence of horticulture, or storage pits at the case study sites. Therefore, I pose the question- Where did the maize originate? The radiocarbon dates associated with the Archaic Sites LA 20241, LA 38597, and LA 112766, supports that the maize may have migrated from south to north. Maize originated in Mexico (Matson

1999). Radiocarbon dates support a documented northward movement into the Southwest from Mexico. The Guila Naquitz site, in Oaxaca, Mexico, is south of Arizona and west of Texas, and radiocarbon dates to 5420 BP (Piperno and Flannery 2001; see Figure 3). This site may have been a source of maize migration into the Permian Basin of southeastern New Mexico.

Another hypothesis is that Archaic groups may have informally grown maize along the Pecos River. The maturity period for prehistoric maize is much shorter than modern maize (Diehl 2005). The growing season may have become part of the seasonal round with a three month stop to grow maize before continuing. The lack of storage pits and ceramics during the Archaic period indicates that other methods of storage were in use (NPS 2016). Woven baskets and leather pouches may have been used as storage as they were during the Early Formative period. Early basket weaving is well documented in the Southwest. The Puebloan cultures are known for, and were called the Basketmaker culture due to their proficiency and proliferate weaving of goods.

The progression of the technology of the Basketmaker culture between the Late Archaic and Early Formative periods is stated in this 2016 NPS quote- “The Basketmaker II people included the early people who lived in cave shelters in the San Juan River drainage. Excavation of their sites yielded a large number of baskets, corn, and evidence of human burials. It was not until the Late Basketmaker II Era (AD 50–AD 500) that people lived in crude pit-houses. During the later portion of this period fired pottery was introduced to the Basketmakers, which due to regional and evolutionary differences greatly aided in dating and tracking pottery origins following archaeological excavations”.

The Basketmaker culture included the Ancestral Puebloans, the Hohokam, and the Mogollon. The case study sites are located on the border of the Ancestral Puebloan and the Mogollon regions. The Mogollon region extends into Mexico and includes the Guila Naquitz site. Maize present at Guila Naquitz Site could have been traded and transported in the Permian Basin of southeastern New Mexico.

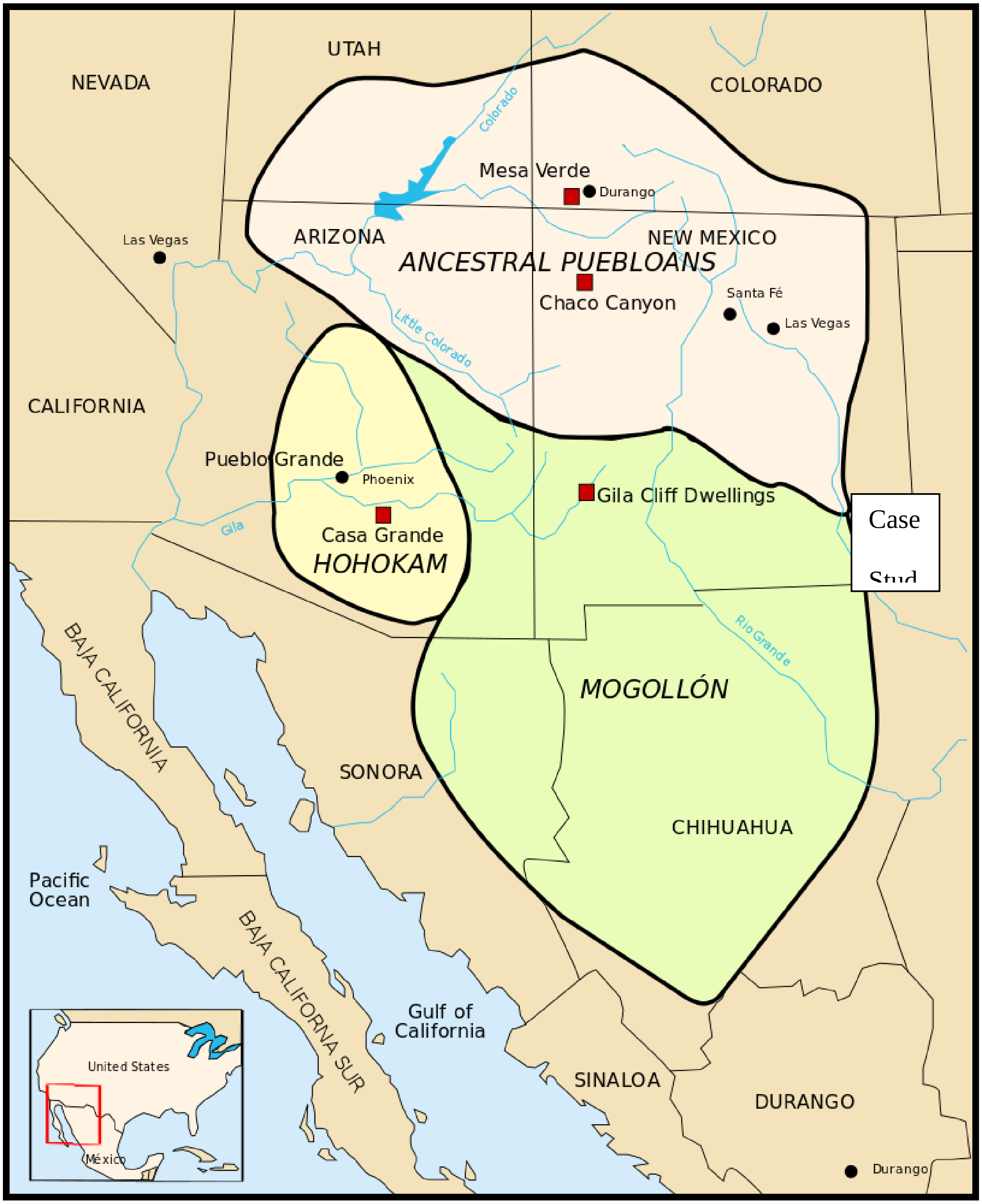


Figure 32- Map Showing Cultural Affiliation.
Adapted from CNM mytext.cnm.edu/lesson/ancient-culture-region

Woven storage vessels would likely not survive to become a part of the archaeological record. Continued research on cultural items located in this region may answer this question more conclusively. Ceramics assemblages from the case study sites indicate that most vessels were local brownware (Goar et al. 2022) that date to the Formative period. However, a small presence of both El Paso Plain Brownware and El Paso polychrome from Site LA 112766 indicates that trade was occurring from the south. The El Paso Plain Brownware dates to AD 200, the Late Archaic, while the El Paso Polychrome dates to AD 1250 the Late Formative Goar et al. 2022). This evidence indicates that trade was occurring between groups via the south (Texas) and groups in the Permian Basin of southeastern New Mexico as early as the Late Archaic period. Petrographic evidence verifies ceramics originating in the south, and verifies ceramics originating from the west, specifically Lincoln County.

Although the Archaic period was aceramic in southeast New Mexico, prehistoric groups did have well-developed lithic technology. The high volume of large metates and manos recovered from the case study sites could indicate that maize was ground into flour or meal for easier transportation. Based on the presence of ceramics, a transition period from organic storage vessels, such as woven baskets and leather pouches likely occurred from the Middle Archaic to the Late Archaic when ceramics are present in southeastern New Mexico (Beven 2017).

What extent was maize integrated into the subsistence of prehistoric groups of the Permian Basin of southeastern New Mexico?

The small quantities of maize grains recovered from each feature at the case study sites do not give evidence of large–scale maize use. I do not believe that maize was used to the extent that it was a staple but instead, augmented a hunter gatherer subsistence. The extent of maize use may have fluctuated season to season depending on climatic conditions. Changes in temperature or precipitation can affect the activities conducted during seasonal rounds. Horticulture, if occurring even informally, can be affected by riparian banks where planting occurs becoming flooded or by the lack of water to reach these planting areas (Svizzero 2014). The quantity of game available for hunting would affect the need to plant maize to augment food stores. Climate change can also affect trade routes. If maize is being traded an ebb and flow cycle may appear to match climate patterns (Nelson 2010).

Climate changes in southeast New Mexico may have produced the societal pressures that Mutual Causation Theory suggests causes groups and individuals to act outside their ordinary routine. Increased population in southeastern New Mexico during the Archaic provides a hint that something caused prehistoric groups to move out of the highlands and into the marginal zones of the Permian Basin of southeastern New Mexico. The cause may have been a lack of resources (Katz and Katz 2001:III-5) needed to feed the growing population, societal disruption, or any number of causes that may have presented itself to motivate a portion of the population to inhabit the marginal zones.

Synthesis Summary

Synthesis of the datasets provides an outline of when maize was present. The results of the comparison of 32 southeastern New Mexico maize sites with the case study sites indicate that LA 112766 has maize and is radiocarbon dated to 500–1000 years older than any other prehistoric site in southeastern New Mexico. The “when” is 2876–2626 BC (4825–4575 BP). This date challenges previously known old maize dates, in the

Southwest, and challenges the currently accepted migration and integration patterns of maize into southeastern New Mexico.

Synthesis of the evidence indicates that the "extent of maize use" was minimal. During the Archaic period in southeast New Mexico, maize was not a subsistence staple, but a supplement. Climate changes during Middle Archaic provided the local water needed for horticulture and abundant resources supported a population increase and a need for new territory.

Chapter 7 – Conclusion

This conclusion outlines the evidence used in this investigation, states the theoretical relevance, and summarizes the significance of the data results.

An analysis of maize use during the Archaic and Formative periods in the Permian Basin of southeastern New Mexico through archaeological evidence collected from Sites LA 20241, LA 38597, LA 112766, and LA 113202. Macrobotanical, phytolith, starch, radiocarbon dating, and ceramic analyses were conducted to determine when and to what extent maize use was present in this region.

The theoretical framework includes Marginal Zone and Mutual Causation theories. The Marginal Zone Theory explains the social and environmental pressures, like overpopulation or climate change that promote the cultural transition of expanding into marginal zones previously unoccupied (Svizzero and Tisdell 2014; 13). Mutual Causation Theory explains the process of developing new technologies by building on past knowledge to meet new challenges (Frankell 1985). Prehistoric groups branched out into the uninhabited regions of the Permian Basin of southeastern New Mexico. Hunter and gatherer cultures developed a need to increase their food production to feed the expanding populations and therefore, introduced horticulture as a subsistence form (Bevan 2017). My analysis of this collection of maize sites and associated ceramics, such as red and black El Paso Polychrome and El Paso Brownware at Site LA 112766 indicate long distance trade.

In summary, the identification of a Middle Archaic maize site in the Permian Basin of southeast New Mexico is significant and pushes the earliest appearance of maize back. The discovery of maize at site LA 112766 broadens our understanding of the subsistence patterns of southeastern New Mexico prehistoric groups by adding the possibility of horticulture and trade during the Middle Archaic period. There is no evidence of formal agriculture during the Middle Archaic in southeast New Mexico, however, the presence of maize suggests that an informal form of horticulture may have been adopted into the subsistence strategy of the hunter and gatherer lifeways.

Further investigation of maize sites in the Permian Basin of southeast New Mexico, especially to the south of the case study sites, is recommended to increase the archaeological record of subsistence practices in this area. This study focused on a small percentage of southeast New Mexico. Comparing a larger sample of previously recorded maize sites in the surrounding area can provide more information on maize use. Especially, now that it is demonstrated that maize was part of the subsistence practices of prehistoric groups during the Middle Archaic period.

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