PALEOINDIAN GEOARCHAEOLOGY OF THE UPPER SAN PEDRO RIVER VALLEY, SONORA, MEXICO

by

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STATEMENT BY AUTHOR

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ABSTRACT

This thesis reports the findings of a multi-disciplinary investigation focused on exploring the Paleoindian habitation of the upper San Pedro Valley, Sonora, Mexico. Two recently-identified fluted points stand as the first Clovis evidence reported from the project area, and site AZ:EE:16:5 (ASM/INAH) has the potential of containing intact Clovis archaeology. Several lanceolate points of the Plainview variety mark the first late Paleoindian evidence reported from Northern Sonora. Four newly identified lithic sources may inform our understanding of Paleoindian range and mobility in the valley and Greater Southwest region. However, intensive geochronological determinations demonstrate that terminal Pleistocene and early Holocene alluvial deposits are rare or absent throughout most of the basin in Mexico. The findings of the project indicate that well-known Paleoindian-age deposits identified at Clovis sites in the valley in Arizona are restricted to relatively small areas of the upper basin north of the border.
CHAPTER 1: INTRODUCTION

There is no greater concentration of Paleoindian mammoth kill sites in the New World than the upper San Pedro Valley of the U.S.-Mexico borderlands (G. Haynes 2002). This basin preserves unparalleled evidence of the Southwest’s earliest inhabitants and has achieved a cornerstone position in the history of Paleoindian studies and New World geoarchaeology. The six stratified Clovis sites present in the Arizona portions of the basin—Naco, Leikum, Navarette, Lehner, Murray Springs, and Escapule—represent over one third of the Clovis kill sites currently known to science (G. Haynes 2002). These sites have provided the foundation for our scientific understanding of the Clovis culture, and have been instrumental to establishing the cultural chronology of the earliest Ice-Age peoples of the New World (C.V. Haynes 1991; Holliday 2000; Hemmings 1970; Stanford 1999).

Over one third of the upper San Pedro Valley is situated south of the international boundary in Sonora, Mexico. Despite the rich record known from the valley in Arizona, nothing has of yet been reported about the Paleoindian archaeology in the Sonoran portions of the valley. This is surprising when one considers that all of the Arizona sites are clustered within 30 kilometers of the international boundary, and that half of these sites--Naco, Leikum and Navarette--occur less than 1 kilometer north of the border in Greenbush Draw, a tributary arroyo that extends over 20 km into Mexico.

From all indications, the Clovis culture is well represented throughout Sonora (e.g. Robles and Taylor 1972; Robles 1974; Sanchez 2001). Evidence has also recently
come to light that may indicate a late Paleoindian presence in Northwest Mexico (see Chapter 4). However, Paleoindian research in Sonora remains in its incipient stages, with a paucity of investigated sites and extensive tracts of land throughout the state of which nothing is known. Despite these shortcomings, the available evidence demonstrates that the Paleoindian occupation of the Southwest United States and Northwest Mexico is a phenomenon that extended uninterrupted across the current international boundary and, therefore, cannot be fully understood if investigations are restricted to one side of the border. Furthermore, the upper San Pedro is unique in that it is the only drainage system in North America with abundant, well-documented Paleoindian sites that crosses the international border between the U.S. and Mexico. It is clear that a complete understanding the early human habitation of this basin requires work on both sides of the border. The rich Paleoindian record and dense concentration of buried Clovis sites in the upper San Pedro of Arizona indicate the likelihood of additional evidence in the archaeologically unknown Mexican portions of the valley. Therefore, systematic efforts aimed at investigating the Paleoindian occupation of the San Pedro Valley of Sonora have the potential of yielding information that will provide a more complete understanding of the early habitation of this important region of the Southwest United States and Northwest Mexico.

The purpose of this thesis is to report field investigations undertaken by the author in the upper San Pedro Valley of Sonora, Mexico during the 2004 and 2005 field seasons. This project marks the initial exploratory efforts aimed at systematically investigating the early human occupation of the Mexican portions of the valley. A
geoarchaeological approach provided the foundation for this study. Essentially, the
problem of locating stratified Paleoindian archaeological sites is one of determining
where in the landscape intact Paleoindian-age sediments are preserved. To achieve this
end, the study utilized a combination of geomorphology, biostratigraphy, and selective
archaeological survey. This approach required a comprehensive strategy that integrated
four major objectives: (1) documentation and geochronological determinations of the
alluvial stratigraphy of the upper San Pedro basin in Mexico in order to assess the
preservation and extent of Paleoindian-age deposits; (2) documentation of potential
Paleoindian archaeological sites; (3) documentation of Pleistocene faunal locales and
associated stratigraphy, with an emphasis on determining the potential for artifact
associations; and (4) documentation of the distribution and metric attributes of
Paleoindian artifacts identified in the Mexican portions of the valley. The result of this
investigation is an inter-disciplinary data set that is providing a more complete
understanding of the Paleoindian habitation throughout the entire upper San Pedro basin
and Greater Southwest region.

This thesis is organized into four major sections. Following introductory
materials and a description of the physiography of the upper San Pedro Valley, Chapter 1
provides a review of the Quaternary geology and history of Paleoindian research in the
basin. Emil Haury’s (1953; et al. 1959) excavations of the Naco and Lehner sites, and
Springs, Escapule, and Lehner yielded most of what is known of the Paleoindian record
of the upper San Pedro. The current project is meant to supplement and complement this
pioneering research and a review is thus warranted. Chapter 1 also includes the methods utilized in the course of this investigation. The nature of this project and its unique geographical setting required a dynamic, multi-disciplinary approach. Part of this chapter is dedicated to explaining the variety of methods employed by this study, both in the field and in the laboratory. Chapter 2 reports archaeological and paleontological sites investigated as part of this project; and descriptions of Paleoindian artifacts identified in the project area. Chapter 3 describes the late Quaternary alluvial stratigraphy of the basin in Mexico and reports the results of geochronological determinations. Chapter 4 provides a discussion and conclusion intended to place the results of the project and the Paleoindian record known from the upper San Pedro Valley in a broad regional context, examining the implications of the recent findings.

Background

Landscape and Physical Geography

The San Pedro River flows from south to north, extending 150 miles from its headwaters near the copper-mining town of Cananea, Sonora to its confluence with the Gila River near Winkelman, Arizona. The upper San Pedro Valley is that portion of the basin situated south of St. David, Arizona. The international border bisects the upper valley at N 30° 20’ and the area covered by this project is the 1113km² of the upper San Pedro basin located south of the boundary in Sonora, Mexico. The upper San Pedro Valley in Mexico is bounded to the east by Sierra San Jose, to the west by Sierra Mariquita, and to the south by the Sierra de los Ajos (Figure 1.1).
The upper San Pedro is situated in the western portion of the Chihuahuan Desert section of the Basin and Range geomorphic province. In general, vegetation in the basin grades from mesquite bosque, desert scrub, and desert grassland in the valley, to oak woodlands and eventually pine-fir forests in the mountains (Hanson 2001; McGuire 1997; USDA and AZ. Water Commission 1977). Large portions of the upper basin in
Mexico are heavily overgrazed, exhibiting a drastic reduction or complete loss of annual grasses and forbs in some areas.

The valley topography is typical of the Basin and Range geomorphic province that formed during the late Miocene, between 14 and 6 million years ago (Christensen and Purcell 1985). Long mountain ridges extend in a roughly north-south direction essentially providing the natural boundaries of the wide basin. Alluvial fans, plains, and river terraces characterize the valley floor.

A bird’s eye view of the Mexican reaches of the San Pedro basin reveals that the river’s tributary arroyos are arranged in a radiating pattern, with major drainages approaching the main stem river channel from the west, south and east. These tributary streams of the San Pedro River are model examples of the arroyos and gullies that characterize the Basin and Range geomorphic province of the southwestern United States and Northwestern Mexico (Cooke and Reeves 1976; Waters 1991). Generally too deep to receive overbank deposition, the vertical walls of the arroyos deepen and widen in response to seasonal precipitation and floods. The severely dissected character of the basin is a recent condition and historic erosion within the valley is well documented (Bryan 1925).

Quaternary Geology

The basin fill of the San Pedro Valley is composed of a coarsening upward sequence of Pliocene and early Pleistocene deposits known as the St. David Formation (Gray 1967; C.V. Haynes 1987). The St. David Formation consists of three
lithostratigraphic members: the lower member consists of red mudstones, siltstones and fine sandstones; the middle member is characterized by a dominance of red and green claystones, marls, tuffs and fine-grained tan sandstones; the uppermost member consists of red sandy gravel, red mudstone and calcareous buried soils (Gray; 1965; 1967; C.V. Haynes 1987 Johnson et al. 1975; Lindsay 1984; Lindsay et al. 1990a; 1990b).

Gray (1965) first determined the age of the St. David formation based on associated fossil remains and stratigraphic correlation. Later, the sequences of the St. David formation were the subject of the first terrestrial paleomagnetic polarity study conducted in North America, which allowed for better chronologic determinations (Johnson et al. 1975). Johnson et al.’s (1975) scheme, which was later replicated by Lindsay et al. (1990a), demonstrates that the lower member has reversed polarity, interpreted as the Gilbert magnetic period. The middle member records the Gauss as well as the lower part of the Matuyama magnetic period, including the Olduvai event. The middle member exposed at California wash also contains a tuff identified as the Huckleberry Ridge ash and is dated to 2.0 mya (Izett 1981). The upper member records the late Matuyama and early Brunhes period periods (Johnson 1975; Lindsay et al. 1990a). These data suggest that deposition of the lowermost, earliest member of the St. David formation began around 4.6 mya and deposition of the uppermost, youngest member ceased at 500 kya, and was followed by a period of net degradation (Gray 1965; Johnson 1975; Lindsay et al. 1990a; 1990b).

Late Quaternary alluvium that overlies and is inset into the St. David formation in many areas of the valley includes the Nexpa gravels, the Murray Springs formation, the
Lehner Ranch Fmation and the Escapule Ranch Fmation (C.V. Haynes 1987).

Chronologically, these strata represent the late Pleistocene and Holocene, and comprise some of the most complete stratigraphic sequences of this time period found in the southwestern U.S. (Waters 1991; 2000; Waters and Haynes 2001). These deposits have yielded a plethora of Clovis-age artifacts and remains of extinct megafauna, and they represent some of the most thoroughly studied and dated late Quaternary deposits in the Greater Southwest (e.g. C.V. Haynes 1987; Hereford 1993; Hemmings 1970; Lindsay et al. 1990b; Waters 2000; Waters and Haynes 2001).

The late Quaternary stratigraphy of the Arizona portions of the basin has been extensively studied at places such as Lehner Ranch and Murray Springs. As summarized by C.V. Haynes (1987), the Millville alluvium was deposited between 100,000-40,000 BP. Subsequent deposition includes the Sobaipuri mudstone and eventually the Coro Marl between 30,000-14,000 RCYBP (Pigati et al. 2004). These shallow water or marshy deposits witnessed desiccation and contributed to the deposition of the Graveyard Gulch channel sands in tributary streams between 13,000 to 11,000 RCYBP. Subsequent cienega deposits known as the “Black Mat” quickly buried terminal Pleistocene evidence of human occupation (C.V. Haynes 1987). Slopewash deposition and aggradation occurred within the tributaries between 9,6000 and 7,500 RCYBP, leaving the Donnet silt. Holocene arroyo cutting and filling is evident after 7,5000 RCYBP, depositing a sequence of later alluvial deposits in the arroyos (Waters and Haynes 2001).

The remarkable preservation of complete late Quaternary deposits in the San Pedro Valley makes the basin geologically unique in the Southwest United States and
Northwest Mexico (Waters 1991; 2000). For the purposes of geologic investigations, the situation in the San Pedro also benefits from the widespread arroyo incision that commonly reveals ancient fossil and artifact-bearing deposits (Antevs 1953; Haury et al. 1959; Haynes 1968; 1987). The combination of these two factors, the preservation and exposure of ancient sediments, makes the basin remarkable in the sense that it has one of the best late Cenozoic terrestrial sequences in North America and has yielded the best record of associations between early man and extinct mammals known on the continent (Lindsay 1984: 1).

Alluvial Geoarchaeology

Geoarchaeology is the application of geological concepts, techniques and approaches to investigate archaeological problems (Brown 1997; Butzer 1982; Waters 1992; Leach 1992). The potential for in situ Paleoindian archaeological sites in the project area hinges upon the preservation of intact Paleoindian-age geologic deposits. The valley’s stratigraphy in Arizona is among the most thoroughly studied and documented in the U.S. providing a wealth of baseline data for intra-valley stratigraphic correlations (e.g. C.V. Haynes 1968, 1987; Waters 2000; Waters and Haynes 2001). Yet, little information exists about the late Quaternary geology south of the border.

Accordingly, the main focus of this investigation is documentation of the alluvial stratigraphy exposed in the gullies and arroyos throughout the Mexican portions of the upper valley.
The high concentration of mammoth-kill sites in the Arizona portions of the valley is, in part, attributable to exceptionally good preservation and exposure of complete sequences of late Quaternary sediments (C.V. Haynes 1987; Waters 1991; 2000; Waters and Haynes 2001). If the geologic factors controlling aggradation, degradation, and landscape stability, at Paleoindian sites such as Curry Draw and Lehner Ranch are operating in the upper valley south of the border, then it is reasonable to expect that the reaches of the upper San Pedro Valley in Sonora will contain additional Clovis-age archaeological sites. That is to say, if the geomorphic variables that control alluvial cycles operate in a similar manner throughout the entire upper basin then it is reasonable to expect similar geomorphic responses and correlative artifact and fossil-bearing stratigraphic sequences on both sides of the border.

However, the exact manner in which the external variables operate on and affect an alluvial system can vary greatly within a drainage basin (Ferring 2001). Variation in the preservation of stratigraphic deposits might be expected throughout the upper basin due to localized complex response exhibited by alluvial systems (Schumm 1973; 1977). The extent and influence of localized specific internal geomorphic variables, and the complexity of localized responses and adjustments to these variables are the critical factors affecting the widespread preservation of alluvial deposits (Ferring 2001; Patton and Schumm 1981; Waters 2000). How these internal geomorphic processes operate throughout the valley and the complexity of the alluvial system’s response to these variables determines whether or not late Pleistocene/early Holocene sediments of the
appropriate Paleoindian timeframe are preserved in the Mexican reaches of the upper valley.

_The Original Inhabitants of the New World and the Greater Southwest: The Clovis/Pre-Clovis Debate_

The initial colonization of the New World and Greater Southwest remains a subject of debate. The long-standing paradigm, known as the “Clovis-first” model, has it that the original inhabitants of the Americas crossed from Asia via the Bering land bridge around 11,500 RCYBP and rapidly colonized the New World via a hypothetical ice-free corridor east of the Rocky Mountains (C.V. Haynes 1964; 1980b). The Clovis culture was recognized in the archaeological record by a bifacial technology with distinctive, readily identifiable fluted projectile points.

Recent findings have, however, called the “Clovis-first” model into question. The widespread acceptance of the Monte Verde site in southern Chile has tentatively established a pre-Clovis occupation in South America around 12,500 RCYBP (Dillehay 1989; 1997; 2000). Although somewhat equivocal, sites in eastern North America such as Meadowcroft rock shelter (Adavasio et al. 1977; 1999), and Cactus Hill (McAvoy and McAvoy 1997) suggest that North America may have been inhabited by roughly 12,000 RCYBP and possibly as early as 15,000 RCYBP.

The Southwestern United States has been the site of a number of pre-Clovis claims (e.g. Budinger 2004; Carter 1980; Hibben 1941; Leakey et al. 1968; Peru 1984). However, most of these sites are discounted due to a variety of reasons including: problematic stratigraphic context; a lack of artifacts that were obviously manufactured by
humans; and problematic radiometric chronologies (Waters 1985; Dincauze 1984; Faught and Freeman 1998).

One intriguing pre-Clovis claim referred to as the Malpais complex is known from Northwest Mexico (Hayden 1967; 1976; Moreno 2005). Malpais sites are assemblages of heavily patinated, crude flaked stone tools for chopping and scraping found on ancient alluvial terraces and relict Pleistocene surfaces. Unlike other pre-Clovis claims which hinge upon a single site, the Malpais phenomenon is represented by a cluster of sites that are distributed across Northwestern Sonora, from the La Playa site, near the town of Trincheras, to the Colorado River delta region (Moreno 2005). This cluster of allegedly early sites is intriguing when viewed in the perspective of a hypothetical pre-Clovis coastal migration (Dixon 2001). However, no Malpais artifacts have been recovered from stratified contexts and there are currently no solid radiometric dates associated with Malpais archaeology.

In light of the rich Clovis record known from the upper San Pedro Valley, it is possible that this basin attracted these, or other, pre-Clovis inhabitants. The well-preserved, relatively complete late Quaternary stratigraphic sequences in the basin have the potential of yielding pre-Clovis evidence in a secure stratigraphic context that may inform the controversial Clovis/pre-Clovis debate. In any event, continued criticisms that Paleoindian researchers know only about the most obvious sites or fail to search for pre-Clovis evidence in a systematic manner (e.g. Butzer 1988; Grayson 1988; Meltzer 1989) underscore the need for comprehensive examinations of late Pleistocene sediments in the upper San Pedro Valley.
Previous Paleoindian Research in the Upper San Pedro: The Clovis Culture

Known by a distinctive type of concave-base, fluted lanceolate projectile point, the Clovis culture represents the first undisputed human presence in the Americas (G. Haynes 2002). In addition to the distinctive projectile point, hallmarks of the Classic Clovis complex include blade technology, large prismatic blades, and blade tools (Collins 1999a; 1999b). Fluted points have been reported from every region of North America, except those areas covered by ice during the late Wisconsin period (Collins 1999b; Anderson et al. 1998). Surface finds of Clovis points have been reported in Mexico from Sonora to Chiapas (Sanchez 2001). Stratified Clovis-age archaeological sites, most of which are mammoth kills, are rare and date between 11,570 and 10,750 RCYBP (G. Haynes 2002).

Paleoindian research in the upper San Pedro Valley began with Emil W. Haury’s excavation of the Naco mammoth-kill site in 1952 (Figure 3.2, # 3). Mark Navarette discovered the site in 1951 when he observed mammoth bones and, later, stone tools eroding out of Greenbush Draw, a major tributary of the San Pedro River. Excavated in a short field season of four days, the site yielded eight fluted projectile points associated with the remains of *Mammuthus columbi* (Haury 1953).

Ernst Antevs (1953) conducted the geologic investigations and reported the stratigraphic context of the archaeological materials. The mammoth remains and points were contained in lacustrine clay, underlain by rust-colored fine to pebbly fluvial sand that was underlain by a deep (3m), apparently widespread, eroded gravel deposit. Antevs
(1953) provided an alluvial chronological age of 10,000 to 11,000 years old for the Clovis materials. Archaeologists have since excavated two additional human-mammoth sites in Greenbush Draw, the Leikum and Navarrete sites (Figure 4.2, # 4 and # 5) that occur less than one kilometer from the Naco site (Agenbroad 1967; Huckell 1982; n.d.; Saunders 1980).

While Haury was excavating at Naco, rancher Ed Lehner reported the occurrence of mammoth remains eroding out of an arroyo at his property roughly 18 kilometers to the west (Haury et al. 1959). This led to the excavations in December of 1955 and February of 1956 of the now famous Lehner Clovis site. The excavations uncovered the remains of 13 mammoths as well as horse, bison, camel, bear, tapir, canid and smaller fauna. The Lehner site achieved two notable “firsts” in the history of Paleoindian studies; it was the site of the first Clovis radiocarbon dates and the site of the first identified Clovis hearths. The documented artifacts and features include 13 Clovis points, eight flake tools, one chopping tool, a small amount of flake debris, and four hearths (Haury et al. 1959; C.V. Haynes 1982). A dozen radiocarbon dates indicate an age of roughly 10,940 RCYBP (Taylor et. al. 1996).

During the course of the excavations, archaeologists discovered that the site’s stratigraphy contained “a distinctive dark band, almost black in color, representing a silty clay…the exposed bones in the arroyo bank lie directly below this black layer” (Haury et al. 1959: 6). Haury et al. (1959:32) immediately recognized that the Black Mat had rapidly buried of the archaeological remains subsequent to the kill, reporting “this layer directly overlies charcoal in the hearths and mammoth bones…it evidently began forming
directly upon the filling of the stream channel before the charcoal was dispersed and the bone disintegrated.”

Antev’s (1959) “black swamp soil” would come to be widely known as the “Black Mat” (C.V. Haynes 1968; 1987; Haynes and Waters 1987). Early in the course of Paleoindian investigations in the valley, this black organic clay was recognized as a clear marker of stratigraphic integrity essentially capping intact Clovis-age deposits (Antevs 1959; C.V. Haynes 1968). The clear contrast between the black mat and underlying units allows for the identification of Clovis age surfaces simply by following its lower contact (C.V. Haynes 1973).

In 1965 and 1966, Pete Mehringer and Vance Haynes located three additional Paleoindian sites: Escapule, Schaldack, and the Murray Springs site (C.V. Haynes 1974). The Escapule site contained mammoth remains and two fluted points with broken tips buried beneath the black mat. Local rancher Lou Escapule recovered the points earlier, but photographs taken of the points in situ ensure the validity of association (Hemmings and Haynes 1969). Two isolated projectile points were found on the surface in the vicinity of the Schaldack site, including one Clovis point, and a lanceolate point showing a remarkable affinity to Dalton technologies (Agenbroad 1967; Huckell 1982).

Murray Springs was excavated over the course of six field seasons from 1966 to 1971. It is a unique Clovis site in the fact that it contains three distinct activity areas where Paleoindian hunters killed mammoth and bison and occupied a campsite (Hemmings 1970; C.V. Haynes 1980a; 1981; 1987). A large assemblage of projectile points, flake tools, and thousands of flakes from discrete knapping clusters attest to
exceptional preservation beneath the black mat, as do sealed mammoth track impressions and a “shaft straightener” fashioned from carved mammoth bone (Hemmings 1970). Eight radiocarbon dates from the site, indicating an age of approximately 10,950 RCYBP, make it one of the latest Clovis sites in North America (Taylor et al. 1996).

In 1974 and 1975 C.V. Haynes resumed investigations at the Lehner Site. The excavations uncovered more mammoth remains, the remains of small game, chert flakes and tools, and a large Clovis-aged roasting pit. The radiocarbon dates indicate that the occupation “occurred essentially at the same time as Murray Springs” (C.V. Haynes 1982: 332). Haynes (1982; 1987) confirmed that the Lehner site stratigraphy was nearly identical to Curry Draw, though not as well as exposed and subjected to greater degree of bioturbation.

C.V. Haynes’ work at both Murray Springs and Lehner, as well as other sites in the upper basin, demonstrated that buried Clovis sites in the San Pedro Valley occur in a predictable, repeated stratigraphic sequence that is identifiable over large areas. Distinctive late Pleistocene deposits at Clovis sites in the Arizona portions of the basin include the Coro Marl, which was deposited 30,000-14,000 RCYBP (Pigati et al. 2004). The Coro Marl is unconformably overlain by the Clovis-aged Graveyard Gulch sands, which are in turn abruptly covered by the Black Mat, also termed the Clanton Clay, which was deposited 10,800-9,700 RCYBP (C.V. Haynes 1987; Waters and Haynes 1987). These late Pleistocene sequences recognized at Clovis sites in the valley, the Black Mat and the Coro Marl, are visually distinctive allowing for rapid identification where they occur.
Early Holocene Archaeology: Late Paleoindian and Early Archaic

The Folsom complex follows the Clovis complex in radiocarbon time and stratigraphic position in the Plains and in the Southern Basin and Range Province of the U.S. Southwest (Holliday 200; Taylor et al. 1996). The Folsom point is characterized by a fluting scar that often encompasses the entire surface of the projectile point and fine edge retouch by pressure flaking. Several early Holocene complexes that are differentiated on the basis of distinct styles of lanceolate projectile points have been identified on the High Plains. Statigraphic relationships and radiocarbon dates indicate that, following the Folsom complex, the Plainview, Agate Basin/Hell Gap, and Cody complexes developed in that order between about 10,900 - 7000 RCPYBP (Holliday 1997; 2000). Although the late Paleoindian lanceolate point complexes on the High Plains are often thought to represent continuations of Folsom settlement and economy during the early Holocene, the transition to an “Archaic” economy might have already taken place in surrounding regions, including the U.S. Southwest (Faught and Freeman 1998; Frison 1992; Meltzer 1988).

Investigated post-Clovis Paleoindian sites are, as of yet, absent in the San Pedro basin. However, limited evidence indicates a late Paleoindian presence in the region. Four Plainview points and two possible Folsom points were reported from surface contexts from adjacent river valleys in Southern Arizona (Agenbroad 1967; Huckell 1982; Faught and Freeman 1998). Additionally, an isolated projectile point recovered from the surface by C.V. Haynes in the Schaldack area shows a remarkable affinity to
Dalton technologies (Agenbroad 1967; Huckell 1982). The age and adaptive character of the Sulphur Springs stage of the early Archaic, dated to 9,900 RCYBP, but possibly beginning as early as 10,400 RCYBP, is of particular importance in this region (Waters 1986).

**Methodology**

The methodology for this study included several steps. First, the extensive area of the upper San Pedro basin of Mexico was subdivided into six arbitrarily defined geographic zones. Second, the general distribution of landforms, including hills, floodplains, terraces, alluvial fans and tributary drainages, was identified from INEGI (Instituto Nacional de Estadistica Geografia e Informacion) 1:50,000-scale topographic maps. Landsat images of the project area, as well as INEGI and U.S. Geological Survey/Customs Service 1:25,000-scale aerial photomaps were then used to identify deeply incised arroyo and gully channels. Major arroyo channels in each geographic zone were then selected for reconnaissance and investigation. Selection of research locales was based on several factors including presence of cutbank exposures revealing thick alluvial deposits, access to property and security issues related to working on the U.S-Mexico border.

The primary fieldwork strategy consisted of pedestrian survey of the major tributary arroyos selected as research locales in order to conduct detailed investigations of the alluvial stratigraphy and identify archaeological and paleontological locales. The gullies and arroyos of the project area are conducive to geoarchaeological studies in that many have incised through thick late Pleistocene and Holocene alluvial deposits exposing
fossil- and artifact-bearing alluvium and buried soils. The stratigraphic clarity afforded by these arroyo exposures is exceptional and they were found to provide a consistent view of alluvial deposits throughout the study area.

Stratigraphic exposures were documented, described, and sampled in the field. Descriptions were carried out using terminology following standard geological and pedological terminology (Compton 1985; Soil Survey Staff 1999; Birkeland 1999). Lithostratigraphic units were designated utilizing letters and sequential numbers, beginning with 1 for the lowest observed strata. Buried soils were described utilizing standard USDA nomenclature for master horizons and selected subordinate distinctions (after Birkeland 1999 and Soil Survey Staff 1999). No attempt, however, is made to classify buried soils to the order or suborder level. The suffix “b” designates buried soils in the field descriptions. Numbers placed after the “b” are used to differentiate buried soils occurring in vertical sequence from the top down (after Holliday 2004 and Birkeland 1999). When making widespread correlations across the study area, pedostratigraphic units were designated by Roman numerals beginning with I at the top.

Radiocarbon Dating

Radiocarbon ages of alluvial deposits were determined using charcoal as well as soil organic matter from buried soil horizons. While there are certain issues inherent to radiocarbon dating organic constituents of buried soils (Scharpenseel 1970; Matthews 1985; Martin and Johnson 1995; Abbot and Stafford 1996; McGeehin et al. 2001), numerous studies have shown that these materials can provide adequate age control,
particularly in the arid environments that characterize western North America (e.g., Mayer et al. 2005; Haas et al. 1986; Holliday et al. 1994; Rawling et al. 2003). Ages of charcoal from sediments provide good minimum estimates for age of deposition, while soil organic matter provides minimum ages of stability and soil formation, as well as maximum ages for deposition of overlying materials.

Samples underwent a standard acid-base-acid treatment to remove carbonate and humate contaminants, and to isolate specific fractions of organic matter (after Abbot and Stafford 1996; Mayer et al. 2005). Charcoal ages were derived for samples pretreated for carbonate and humate removal. Samples were processed at the University of Arizona NSF-AMS facility (AA). Radiocarbon ages were corrected for isotopic fractionation and are presented in uncalibrated radiocarbon years ($^{14}$C yr B.P) before present (Table 1.1).

Relative Dating

In the absence of organic constituents suitable for radiocarbon dating, artifact content and degree of soil development were the criteria utilized to determine the relative chronology of alluvial deposits. Artifacts such as ceramic sherds, groundstone, and diagnostic projectile point types contained within alluvial deposits serve as index fossils that provide reliable approximate age indicators. Buried alluvial soils also provided effective tools for determining the relative age of deposits. In the arid environments of the Southwest U.S. and Northwest Mexico, extreme weathering and soil development that is characterized by very thick, rubified argillic horizons with heavy clay and mineral translocation are characteristics of very ancient Pleistocene soils, while weakly expressed
cambic, argillic and calcic horizons are indicative of middle to late Holocene soils (Birkeland 1999; Gile et al. 1981; Huckleberry 1997; 2001; Machette 1985; McAuliffe
1995).

Table 1.1 Radiocarbon Ages from the Upper San Pedro Basin, Sonora

<table>
<thead>
<tr>
<th>Location</th>
<th>Lab#</th>
<th>Material</th>
<th>Fraction</th>
<th>Age $^{14}C$ yr B.P.</th>
<th>$\delta^{13}C$</th>
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<td><strong>Western Valley-El Tejano Arroyo</strong></td>
<td></td>
<td></td>
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<td></td>
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<tr>
<td>Stratum ET5, top of soil hoz Ab1/Btwb1</td>
<td>AA63286</td>
<td>soil</td>
<td>humates$^a$</td>
<td>380 +/- 37</td>
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<tr>
<td>Stratum ET5, top of soil hoz Ab1/Btwb1</td>
<td>AA63337</td>
<td>soil</td>
<td>residue$^b$</td>
<td>533 +/- 40</td>
<td>-15.45</td>
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<td>Stratum ET4, top of soil hoz Ab2/Bwb2</td>
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<td>soil</td>
<td>humates</td>
<td>1584 +/- 38</td>
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<td>Stratum ET3, Top of soil hoz Ab3/Bwb3</td>
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<td>humates</td>
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<td>soil</td>
<td>residue</td>
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</tr>
<tr>
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</tr>
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<td>soil</td>
<td>residue</td>
<td>4829 +/- 72</td>
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<td><strong>North of Sierra San Jose-AZ:EE:12:5</strong></td>
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<td>Stratum P4, top of soil Ab1/Btwb1</td>
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<td>humates</td>
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<td>charcoal</td>
<td>~</td>
<td>323 +/- 40</td>
<td>-23.65</td>
</tr>
<tr>
<td>Stratum AC5, top of soil hoz Ab2/Bwb2</td>
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<td>soil</td>
<td>humates</td>
<td>538 +/- 37</td>
<td>-16.97</td>
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<td>residue</td>
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<td>-17.92</td>
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<td><strong>Southern Valley--Arroyo Seco-AZ:EE:16:5</strong></td>
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<td>Stratum LM1, top of soil hoz Btkb</td>
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<td>humates</td>
<td>1823 +/- 40</td>
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<td>soil</td>
<td>residue</td>
<td>1987 +/- 39</td>
<td>-18.52</td>
</tr>
<tr>
<td><strong>Eastern Valley-El Sauz Arroyo</strong></td>
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<td>soil</td>
<td>residue</td>
<td>1095 +/- 38</td>
<td>-13.57</td>
</tr>
</tbody>
</table>

$^a$ Base soluble fraction, reprecipitated via a second acid treatment

$^b$ Base insoluble fraction
Archaeological Reconnaissance

Field explorations combined strategic archaeological survey with geological investigations. Selective archaeological surveys proceeded with two strategies. The first of these was extensive communication and coordination with local residents, ranchers and landowners in the project area. This approach was based on the fact that the detection of Paleoindian sites during the past 50 years has been the result of fortuitous circumstances by avocationals rather than systematic field inspection by professionals. This point is underscored by the fact that private citizens found most of the fluted points known in adjacent Arizona (Huckell 1982) and five of the six stratified Clovis sites in the U.S. portions of the San Pedro Valley. Considering the lack of previous systematic exploratory efforts in the upper San Pedro basin of Sonora, it was deemed likely that local residents would have the best information about obvious Paleoindian sites. Coordination with local residents was aimed at identifying Paleoindian artifacts present in local collections as well as obvious paleontological locales with potential for artifact associations.

The second reconnaissance strategy consisted of targeting high probability areas such as springs, rockshelters and outcrops of siliceous stone. Promising areas were arbitrarily selected primarily due to the fact that they could have provided important resources for Paleoindian bands operating in the basin. Many of the sources for the lithic materials in Clovis assemblages from the valley remain unidentified (Huckell 2004). Documenting prehistoric quarries and lithic sources has the potential of greatly enhancing our understanding of Paleoindian range and mobility in the region. Springs would have
been attractive to both humans and prey species. In addition, all of the known
Paleoindian sites in the valley occur in the lowland areas of the valley floor. Since
Paleoindian rockshelter sites are unknown in the valley and rare in Paleoindian settlement
patterns in general, the discovery of an early site in such an area would have a profound
impact. Sites identified through archaeological reconnaissance were recorded in
accordance with Instituto Nacional Antropologie e Historia (INAH) and Arizona State
Museum (ASM) standards.
CHAPTER 2: ARCHAEOLOGICAL FINDINGS

Archaeological Sites

Investigations identified several archaeological sites that can further inform our understanding of the Paleoindian occupation of the basin. An open-air, multi-component site in the southernmost reaches of the project area is the best candidate for containing stratified Paleoindian archaeology. While this site, AZ:EE:16:5 (ASM/INAH), contains diagnostic Archaic artifacts, it has also yielded materials that may be representative of an earlier Clovis occupation. The rest of the sites reported here are cryptocrystalline lithic sources and quarry sites. While none of these sites have yielded diagnostic Paleoindian artifacts, they are included as part of this report as they may have provided important sources of knappable stone for Paleoindian bands operating in the valley.

AZ:EE:16:5

AZ:EE:16:5 (INAH /ASM) was identified on the basis of a fluted point basal fragment discovered there by a local resident and brought to the author’s attention. Subsequent investigations found that the site consists of an extensive, moderately high-density concentration of lithic material scattered over a 300 x 150m area.

The site is situated on an arroyo terrace in the lower foothills of the Sierra de los Ajos (Figures 3.2, 2.1). The arroyo drains north to the San Pedro River and the terrain gradually slopes in that direction. The landscape is increasingly hilly to the south toward Sierra de los Ajos. Directly across the ephemeral stream channel to the west the site is a very steep escarpment roughly 45 meters high. The vegetation is sparse grasses and
scattered mesquite trees, with some low oaks in the vicinity. Surface visibility is high throughout the site.

The site consists of a large scatter of flaked stone. A large number of tool forms were observed including several fragmentary projectile points, gravers, scrapers, biface fragments, spokeshaves and hammerstones. No ceramics or groundstone were observed. Several of the projectile point fragments were diagnostic of the Chiricuahua stage of the Cochise culture (Mabry 1998; Justice 2002). While some of the tool forms observed such as gravers and scrapers are reminiscent of diagnostic Paleoindian artifacts (Gramly 2000), the identification of these tool forms as Paleoindian is equivocal at best. In the absence of additional diagnostic Paleoindian artifacts the evidence for a true Clovis occupation is equivocal. Despite this uncertainty, there are indications of buried terminal Pleistocene deposits at the site.

The surface of the site is comprised of tan sands and gravels, apparently from Holocene deposition. A side gully that incises the terrace 300 meters to the south of the site affords a measure of stratigraphic clarity with which to assess the underlying deposits (Figure 2.2). The stratigraphy revealed here consists of an upper unit of bedded silts and sands (unit LM 3), which is underlain by sands with some randomly dispersed gravels and gravel lenses (unit LM 2). The lowest unit exposed consists of a thick layer of silt loam (unit LM 1), the top of which exhibits a buried Btk soil horizon (Btkb1). Unit LM 2 contains groundstone and flakestone artifacts. SOM radiocarbon ages from the Btkb1 horizon are $1823\pm40^{14}C$ years B.P on the humate fraction and $1987\pm39^{14}C$ years B.P on the base insoluble residue (Figure 2.2, Table 1.1). The underlying units are not
exposed by incision and thus their age and nature remains unknown. In light of the fluted point fragment recovered in the vicinity, the possibility remains that there are intact subsurface Paleoindian-age deposits in this area.

Fig 2.1 Site AZ:EE:16:5 Overview

Fig 2.2 Site AZ:EE:16:5 Stratigraphy
**AZ:EE:12:6**

AZ:EE:12:6 (INAH/ASM) is a quarry site associated with a chert outcrop that occurs in the massive limestone deposits on the western flank of Sierra San Jose (Figure 3.2). A large number of primary decortication flakes and secondary biface thinning flakes occur in an area ca. 20x30 meters adjacent to the siliceous outcrop (Figure 2.3). The material is coarse-grained chert that ranges between weak red (7.5r 5/2) and light red brown (2.5 yr 6/4). No diagnostic tool forms were observed. At a macroscopic level this stone appears similar to a variety of stone known from the Murray Springs and Naco Clovis assemblages (Haury et al. 1953; Hemmings 1973; Huckell 2004) and sourcing studies may further clarify this possibility.

![Figure 2.3 Site AZ:EE:12:6 Overview](image-url)
Western Valley Quarry

Investigations identified a quarry site in the rolling hill country of the western portions of the valley, roughly 10 kilometers west of Ejido Morelos. The site is an isolated chert outcrop occurring on the south side of a low grassy hill (Figure 2.4). This high quality cryptocrystalline chert ranges in color from opaque white (N8/) to translucent bluish gray (5PB 8/1). Flakes of the same material occur adjacent to the outcrop in a dense 30x70 meter concentration. Most of these artifacts are primary decortication and secondary reduction flakes. No diagnostic tool forms were observed, but this chert is reminiscent of a distinctive white chert known from Clovis assemblages in the San Pedro of Arizona (Haury 1953; Haury et al. 1959; Hemmings 1970; Huckell 2004).

Figure 2.4 Western Valley Quarry Overview
Other Lithic Sources

Diffuse scatters of agatized petrified wood occur over a large (ca 5 x 5 km) area on the southern flakes of Sierra San Jose in the vicinity of Ejido Cuauhtemoc. Pieces of this material occur in a very low-density scatter and exhibit a wide range of characteristics. Texturally, the stone varies from rough, coarse-grained, to extremely silicified, cryptocrystalline nodules suitable for sophisticated knapping techniques. The material exhibits a wide range of colors (figure 2.5) including dark gray (N4/) and black (N2.5/), a variety of reds (7.5R 4/8 – 10R 4/8) and dusky red (7.5 R2.5/4), as well as purple pale red (5R 6/3) and grayish green (5G 4/2). Recent commercial exploitation has resulted in the removal of most of the larger petrified wood pieces, but primary and secondary flakes, as well as isolated tools observed in the area attest to the prehistoric use of this stone. Samples of this material have macroscopic similarities to a single reworked petrified wood Clovis point known from Murray Springs (Hemmings 1970; Huckell 2004), suggesting that Clovis hunters in the valley may have utilized this lithic source.

A quartz crystal source was identified in the far western reaches of the valley. Large clusters of transparent, pure quartz crystals were observed in granite outcrops atop the low hills that occur in this area of the valley. While lithic reduction debitage indicating prehistoric utilization of this material is absent, this source is included as part of this report due to the number of quartz crystal Clovis artifacts known from the valley (e.g. Haury et al 1959), and the region at large (see Chapter 4).
Figure 2.5 Samples of Petrified Wood from South of Sierra San Jose

Figure 2.6 Samples of Chert Nodules Present in Arroyo Gravels Throughout Upper San Pedro Valley
In addition to the primary lithic sources described above, isolated nodules of a wide variety of cherts were found in arroyo gravels essentially throughout the entire project area (figure 2.6). These cherts are typically high quality cryptocrystalline nodules suitable for producing bifaces and blade cores that display a wide variety of colors, ranging from pale red (5R 4/6), white (N8/), pale yellow (2.5Y 8/2), to translucent pinkish/gray (5YR 7/2). The documented occurrence of these nodules in stream gravels demonstrates the wide variety of lithic materials available to Paleoindian bands roaming the San Pedro Valley and may indicated additional sources of knappable stone in the surrounding mountains.

**Springs and Rockshelters**

Substantial exploratory efforts were dedicated to surveying the vicinity of Agua Verde spring on the western side of Sierra San Jose as well as several rockshelters on the northern uplands of Sierra San Jose. Despite intensive reconnaissance, no potential Paleoindian sites were discovered in any of these areas. In addition, it was found that there is a marked lack of deposition in each of these settings, thereby greatly diminishing the possibility of buried sites.

**Paleontological Sites**

During the course of the project, emphasis was placed upon identifying, documenting and evaluating Pleistocene fossil locales. This focus was based on several considerations. First of all, taxonomic determinations of species represented at these locales have the potential of providing useful biostratigraphical information integral to the geochronological approach of the project. This is particularly important in cases
where alluvial deposits lack organic material suitable for radiocarbon determinations. Second, extending the known range of Paleoindian prey species such as *Mammuthus* and *Bison* can provide clues as to the potential range of Paleoindian peoples who may have had hunting strategies dependent upon these large mammals. Further, every kill site known from the San Pedro in Arizona was discovered first by finding fossilized bones of prey species and then uncovering associated artifacts. Limited evaluation excavations of identified paleontological locales in order to determine artifactual associations, in effect, mimic this historically fruitful strategy.

**AZ:EE:12:5**

Investigations revealed the presence of Pleistocene fossil remains in an arroyo on the bajada north of Sierra San Jose (Figure 3.2, site AZ:EE:12:5 ASM/INAH). The site is located in a south to north running arroyo that incises the alluvial fan on the north side of Sierra San Jose. This site, AZ:EE:12:5 (ASM/INAH), was first discovered by a local rancher five years ago. Recent investigations confirmed the presence of *in situ* fossil remains exposed in the steep arroyo wall (Figure 2.7) and also revealed that erosional activity subsequent to the initial discovery had undercut and collapsed the steep arroyo bank where the fossils occurred, depositing a large debris pile on the arroyo floor (figure 2.8). The rancher who first discovered the remains reported that fossil fragments occurred within the large debris pile. As future precipitation and erosion would certainly destroy the fossil material contained within the debris pile, mitigation procedures were deemed necessary to document the site, salvage the threatened remains, and to quickly and efficiently assess the possibility for associated artifacts.
Figure 2.7 AZ:EE:12:5 *In situ* fossil material

Fig 2.8 Debris slump at AZ:EE:12:5
In situ fossil remains occur 1.5-1.65 mbs in reddish brown silty clay that has extremely hard peds that exhibit heavy clay skins and iron and manganese translocation (Figure 2.9, unit P2). Unit P2 is resting disconformably on red, cemented sands and gravels (stratum P1). The upper portion of P2 contains a bright red, truncated buried Btk horizon (Btkb3). This eroded soil horizon in stratum P2 is disconformably overlain by brown alluvial silts, sands and clays (Figure 2.9, units P3-5). Two buried soil horizons occur in these upper deposits. The lowermost of these is a Ab/Btb horizon at 95-115 cmbs. The upper buried soil consists of an A/Btwb horizon at 38-75 cmbs (figure 2.9).

The debris pile occurs on the channel bed adjacent to and along the steep arroyo bank for 12 meters, extending up to five meters toward the center of the channel with a height of up to 1.5 meters. In addition to stratigraphic documentation at this locale, the debris pile on the arroyo channel floor was excavated in order to recover any fossil or artifact materials that might be contained within. The earth was passed through 1/4 inch mesh screen to maximize recovery of any small specimens, faunal or artifactual, needed to effectively evaluate the possibility of human-megafauna association.

A large amount of fragmentary fossil material was discovered within the debris pile (Figure 2.10). The extremely fragmented nature of these remains is undoubtedly due to their fall to the arroyo floor during the erosional episode that collapsed the bank. Despite the disturbed context, large chunks of sediment adhering to the recovered fossil fragments clearly indicate that they originated in the same stratum as the fossils still preserved in the arroyo wall.
Figure 2.9 Stratigraphy at AZ:EE:12:5

Figure 2.10 Fossil proboscidean rib fragment
The faunal remains are completely lithified, exhibiting complete mineral replacement. Due to their fragmentary nature, most of the recovered fossil fragments are unidentifiable. There are, however, three individual specimens identifiable to element and order level. Two individual fossil specimens are identified as portions of unspecified rib elements, and one individual specimen is identifiable as an unspecified vertebrae fragment. These elements are identifiable as belonging to the order proboscidea. No artifacts were encountered with the fossil remains. The in situ fossil material exposed in the arroyo wall remains unexcavated and in place.

While no organic components suitable for radiocarbon dating are preserved in the fossil bearing deposit, the bright red color and expression of the Btkb3 horizon overlying the elephant remains indicate that it was formed during the late Pleistocene. Despite the lack of species-specific characteristics that would inform a biostratigraphical assessment, stratigraphic position of in situ remains below a buried late Pleistocene soil as well as the heavily mineralized nature of the remains suggests that they have an age in excess of ca. 25,000 years (C. Vance Haynes personal communication; Richard White personal communication). Overlying these Pleistocene deposits at a sharp contact, radiocarbon ages of SOM from the buried Ab2/Btb2 horizon are 1601+/−39 ¹⁴C years B.P on the base insoluble residue fraction and 2517+/−40 ¹⁴C years B.P on the humate fraction (figure 2.9, Table 1.1). Radiocarbon ages of SOM from buried soil horizon Ab1/Btb1 are 866+/−38 ¹⁴C years B.P on the residue fraction and 1552+/−38 ¹⁴C years B.P. (figure 2.9, Table 1.1). In the cases of both radiocarbon-dated buried soil horizons, humate fractions dated
significantly older than the residue fractions. While this is unusual, the older humate

dates are deemed to give a better minimum age of stability and soil formation.

The fossil bearing deposit at AZ:EE:12:5 is either equivalent with the Millville
formation (unit Qmi) identified by C.V. Haynes (1987), or it may be an older fossil
bearing St. David stratum. For the purposes of the current investigation the salient issue is
that the fossilized remains are clearly too ancient to be associated with humans, and
demonstrably lack associated artifacts. The chronostratigraphy in the alluvial deposits
north of Sierra San Jose demonstrates a prominent erosional disconformity between the
underlying Pleistocene deposits and upper late Holocene deposits. Severe erosion has
evidently removed an assuredly large amount of late Quaternary sediments. Paleoindian-
age sediments seem to be rare or absent in alluvial deposits found in the area of the valley
that occurs on the pediment surface north of Sierra San Jose.

AZ:FF:13:7

Investigations identified fossil remains in the southeastern portions of the valley
in the vicinity of Ejido Cuauhtemoc (Figure 3.2). Site AZ:FF:13:7 (INAH/ASM)
contains several loci of fossil materials diffusely spread over 600 m² (Figure 2.11). The
primary locus (L1) at the site consists of the left mammoth mandible fragment and intact
M1 together with several other large unidentified fossil fragments on the floor of a
shallow, gently sloping gully (Figure 2.12). 13 meters to the south investigators
recovered a heavily mineralized Equus (sp) tooth fragment in the midst of several very
small fossil fragments on the ground surface (Figure 2.13, locus L2). 57 meters to the
east of these loci (Figure 2.13), dozens of unidentified fossil fragments occur in a discrete
cluster on the ground surface (locus 3). Occasional isolated unidentifiable fossil fragments occur diffusely scattered on the ground surface for more than 200 meters to the east.

The fossil-bearing stratum, unit LC 2, is tan clay with dispersed pebbles and gravels. This unit is exposed by erosion over much of the surface in the vicinity of the site. Stratigraphic exposures in the site’s main arroyo reveal the fossil bearing clay resting on purple silt stone bedrock, unit LC1 (Figure 2.15). Overlying the fossil-bearing clay in some areas is a red argillic sandy silt loam, unit LC3, also of a Pleistocene age (Figure 2.15). Several small gullies at Rancho Las Cruces have exposures that reveal patches of and uppermost unit that consists of strong brown silty loam with a relict Bt horizon.

Based on the dental remains at least two individuals of two different species, *Equus* and *Mammuthus*, are represented at AZ:FF:13:7. In addition to these specimens the landowner has reportedly collected a number of fossil fragments from the vicinity, including several teeth identifiable as *Camelops*. Analysis of the mammoth M1 tooth fragment from loci 1 (Figure 2.14) documented the following attributes and measurements: 12 ridge plates; 137.3 mm anterior/posterior (missing at least 1 lamellae); 77.4 mm lingual/buccal; 3.13 mm enamel plate thickness at midline; and 6 ridge plates per 100 mm. The ratio of six ridge plates/100mm is on the low end for *Mammuthus columbi*, and on the high end for the more primitive and ancient *Mammutus imperator* (Saunders 1970; Maglio 1973). The enamel thickness is outside the range of variation for all specimens of *M columbi* reported from Arizona (Saunders 1970), but is congruent
with enamel thickness of *M. imperator* (Maglio 1973). In addition, the plates seem to be widely spaced, which is another characteristic of the more primitive and older *M. imperator* (Richard White personal communication). *M. imperator* is an early Rancholeabrean mammoth species with its last appearance in Northern Mexico or the U.S. Southwest in excess of 130,000 years ago (Agenbroad 1984a; G. Haynes 1991; Kurten and Anderson 1980; Maglio 1973).

Figure 2.11 AZ:FF:13:7 Overview

Figure 2.12 AZ:FF:13:7 locus 1 (L1)
Figure 2.13 AZ:FF:13:7 Locus 1

Figure 2.14 Mammuthus imperator M1

Figure 2.15 AZ:FF:13:7 Stratigraphy (stake is 50 cm long)
The fossil-bearing unit at the site is therefore related either to the St. David Formation (Gray 1965; 1967) or the Millville alluvium (Haynes 1987). The presence of a geologic unit of this age at or near the surface at this locale demonstrates a severe degree of late Pleistocene/early Holocene degradation and corresponding lack of Paleoindian-age deposits.

_Paleoindian Artifacts: Attributes and Distribution_

Several diagnostic Paleoindian projectile points were identified during the course of investigations. All of the specimens reported here were discovered by non-professionals and identified through extensive discussions with ranchers and local residents in the project area. While most of the specimens have an unspecific provenience and no geologic context, they are included in this report as they are the first Paleoindian artifacts known from this region in Northern Sonora. The data provided by these specimens can be useful in examining Paleoindian range and mobility, resource procurement, technological variation, and techniques of manufacture and use. Although non-professionals found all of these artifacts, it is worth remembering that avocationals found most of the isolated fluted points in neighboring Arizona and five of the six of the investigated San Pedro Valley sites (Huckell 1982).

A fragmentary Clovis point was found in the southern portions of the valley in the vicinity of Ejido Zaragoza. The point (specimen 1) is a fluted point basal fragment made of transparent quartz crystal (Figures 2.16, 2.17). The point has a lanceolate shape with a moderately concave base. One face of the specimen has one large channel flake, while the opposite face displays two long and narrow overlapping channel flakes. Both faces
exhibit pressure flakes that invade the channel scars from the margins. There is also
limited invasive pressure retouch on the concave basal edge. Exhibiting a simple
transverse snap break, roughly one third of the complete, slightly tapering basal portion
of the point is present. The heavy grinding both on the basal and lateral margins indicate
that the point was successfully completed and subsequently broken during use.

Figure 2.16 Specimen 1 drawing

Figure 2.17 Specimen 1 photo

Local residents found several Paleoindian projectile point fragments during the
1960s reportedly from the area 2-3 kilometers southeast of Naco (Figure 3.2, points 2 and
3). The first of these (specimen 2) is a fluted basal fragment definitely of the Clovis type
(Figures 2.18 and 2.19). This point is made of a grayish/light brown chert. The point
displays large channel flakes, one on each face, and is ground along both the lower lateral
and basal edges. This point exhibits properties similar to the first specimen and fluted
points from the U.S. Southwest in that it has pressure flakes that invade the fluting scars
from both margins and invasive pressure retouch along its concave basal edge. This
unusual specimen displays several indications of its life-use history. One face near the
distal edge bears the remnant of an impact flute scar. Along with this, several intentional
pressure retouch flakes are evident on both faces along its transversely fractured distal edge. This point, apparently completed by a Clovis knapper, was fractured due to impact, and subsequently pressure retouched along its broken front edge to create a scraper edge. While the point displays the same degree of patination and weathering on each of its flake scars, it remains unknown for certain when the latest retouch episode occurred or if it was performed by Clovis knapper. It is certainly possible that the point’s broken basal fragment was curated and utilized as a tool by a later prehistoric person.

Figure 2.18 Specimen 2 drawing

Figure 2.19 Specimen 2 photo

The second projectile point found southeast of Naco is an unfluted lanceolate basal fragment (Figure 3.21, point 3). This well crafted point is completely covered by
parallel to sub-parallel fine pressure retouch (Figures 2.20, 2.21). It displays extensive basal thinning with several long pressure flakes originating from the basal edge that extend along both faces. This specimen has parallel sides with a moderately deep concave base. Both the lower lateral and basal margins exhibit heavy grinding. This lanceolate basal fragment is definitely Paleoindian. Its characteristics such as ground parallel sides, basal concavity depth of 2.4 mm, and vertically pressure-flaked basal thinning are congruent with the Plainview typology (Turner and Hester 1993). The lithic raw material is a very light brown to white chert mottled with red and pink flecks. The entire surface of the point displays heavy erosion and weathering that have smoothed out the flake scars. One side of the point is heavily covered with a dark brown patina, indicating it spent a substantial amount of time on the surface.

One definite, and two probable Paleoindian projectile point fragments are known from the southern portions of the project area in the vicinity of Ejido Cuauhtemoc (figure
3.2, points 4, 5, and 6). The positively identified Paleoindian point is an unfluted, lanceolate basal fragment made of very dark gray to black weathered obsidian (specimen 4, Figures 2.22 and 2.23). This specimen has a concave base and slightly concave, indented sides, resulting in slightly flared basal corners or “ears.” Fine sub-parallel pressure flaking covers the entire point. Both the lower lateral and basal edged are heavily ground and the point exhibits heavy patination. This point fragment shares several remarkable affinities with late Paleoindian Plainview technologies known from the southern high plains (Turner and Hester 1993) and is also very similar to Dalton-like projectile points recently documented in the vicinity of Hermosillo by the author (see Chapter 4).

The first of the two equivocal point fragments (specimen 5, figure 2.24 and 2.25) is a basal fragment made of a light tan/white chert that is identical material to specimen 3,
the Plainview basal fragment found southeast of Naco. Although ambiguous, this specimen has many notable characteristics that are congruent with Plainview typology such as a lanceolate shape, very fine parallel pressure flaking and extensive pressure-flaked basal thinning (Turner and Hester 1993). It is broken transversely from a pressure flaking error that occurred during primary production. The basal and lateral edges are not ground, indicating that this specimen broke in production and was never completed.

A very well crafted mid-section fragment made of olive green/yellow agate also seems to be late Paleoindian (specimen 6, Figure 2.26). Unfortunately, very little of the original point remains, including the diagnostic basal section. However, the remaining portion exhibits several notable characteristics. Production was accomplished by very well crafted parallel pressure flaking. Each flake scar terminates at the center, resulting in a ridge that runs down the centerline of the point. The mid-section also displays a lenticular cross-section, and is reminiscent of the Eden typology (Turner and Hester
1993). These two specimens described above remain equivocal. However, the techniques employed in their construction are striking and extremely suggestive of Paleoindian technologies.

A diagnostic Clovis artifact is known from the southern portions of valley in the foothills area southeast of Ejido Zaragoza (Figure 3.2, point 7). This triangular point is made of gray phenocrystic rhyolite with a black and white tip (Figure 2.27). At first glance the point seems a non-diagnostic triangular specimen. Closer examination, however, reveals the remnant termination of a single flute on one face. The other face exhibits extensive vertically pressure-flaked basal thinning. This unusual specimen also exhibits heavy grinding on its basal lateral margins. This point is the distal half or more of a large fluted specimen that was transversely fractured. Subsequent to the break, the base was re-thinned in order to rejuvenate it into a functional dart point. The remnant fluting scar as well as the heavy basal and lateral grinding evident on the final product indicate that both the initial construction and later re-sharpening of this point was accomplished by a Paleoindian knapper.
Figure 2.26 Specimen 6 photo

Figure 2.27 Specimen 7 photo
CHAPTER 3: LATE QUATERNARY ALLUVIAL STRATIGRAPHY

The nature of this study required a landscape level approach that included the alluvial stratigraphy of the entire San Pedro Valley located in Sonora. This area is geographically extensive and the stratigraphy of valley basins in the arid west tends to be very complex. While it is outside the bounds of the current project to attempt a comprehensive model that describes the entire late Quaternary stratigraphy of the upper San Pedro basin, generalized documentation and chronological evaluations of arroyo stratigraphy provide a means of efficiently evaluating the nature of preservation of Paleoindian-age deposits in the valley south of the border. Therefore, this chapter contains generalized stratigraphic descriptions of the major tributary arroyos throughout the entire range of the project area with a geochronological approach focused on identifying Paleoindian-age deposits.

To facilitate geomorphic investigations the extensive project area was sub-divided into several geographic zones (Figure 3.1). These arbitrarily defined geographic divisions include: (1) the main stem San Pedro River channel and floodplain (2) the western portion of the valley; (3) the south central portions of the valley; (4) the eastern portions of the valley including the area south of Sierra San Jose; (5) the northeastern portions of the valley north of Sierra San Jose; and (6) the upper reaches of Greenbush Draw that occur east of Sierra San Jose. The stratigraphy of the major tributary arroyos in each of these regions is reported, any cultural or paleontological materials within them are described, and evidence for dating of the units is presented and discussed.
Figure 3.1 Satellite Overview of the Upper San Pedro, Sonora with geographic divisions (image used with permission from www.google.earth.com)
Figure 3.2 Project area topographic map with arroyos studied, sites, stratigraphic loci, isolated point find locations, and investigated sites in Arizona portions of valley
The San Pedro River Headwaters, Channel and Floodplain

The San Pedro River in Mexico has an entrenched channel that incises through a well-developed floodplain in places. The river channel begins at 31°11’43” N, 110°12’38’’W at an elevation of 4461 fasl (1360 masl) at the confluence of Las Nutrias arroyo from the west, El Sauz arroyo from the east, and El Riecito arroyo from the south (Figure 3.2). Incision by the river channel in the headwaters area provides a high degree of stratigraphic clarity (Figure 3.2, locus HW).

Headwaters (locus HW)

The lowermost deposit exposed by the entrenched channel in the headwaters area consists of a brown cienega clay deposit (Figure 3.3, unit HW1) that exhibits weathering with a weakly to moderately expressed Btwb horizon. HW 1 is overlain by up to 1.5 meters of brown, bedded silt to fine sand (unit HW 2). This, in turn, is overlain by a dark brown silty clay loam (unit HW3), which exhibits pedogenesis and a series of weakly expressed buried soil horizons. Both units HW 2 and HW 3 contain isolated sherds. The uppermost deposit (unit HW 4) is a light brown, to light yellow brown bedded silts and fine to coarse sands that represent historic deposition. Based on artifact content, correlation with exposures that have been radiocarbon dated, and degree of weathering exhibited by the buried soil horizons, these deposits are assigned to the late Holocene (post-5000 BP) with the uppermost deposit representing historic deposition. As the units underlying these late Holocene deposits are not exposed, their characteristics and age remain unknown (Figure 3.4).
Figure 3.3 Locus HW stratigraphy

Figure 3.4 Locus HW generalized stratigraphic cross-section
River Channel and Floodplain (locus F)

As the river courses to the north, the outside bends of its meanders alternate between incising the late Holocene floodplain and cutting into much older landforms (Figure 3.7). Incision into the older landforms reveals the oldest valley fill observed in the project area. These exposures often consist of channel walls up to six meters high (Figure 3.5). The lowermost exposed deposits are generally red mottled calcareous clay, with red muds and calcareous buried soils. These deposits are overlain by a series of upward-coarsening red sandy gravels. These sequences are lithologically similar to and probably equivalent to the late Pliocene and early Pleistocene St. David Formation known in the Arizona portions of the basin (Gray 1967; C.V. Haynes 1987; Johnson et al. 1975; Lindsay et al. 1990a; 1990b). The upper red gravels are similar to and probably correlate with the “gravel wash” defined by Gray (1967) or the Nexpa gravels known from Curry Draw and described by Haynes (1987) as representing a period of net degradation during the middle Pleistocene.

The San Pedro River channel crosses the international border at N 31°20’ at an elevation of 4200 fasl (1280 masl). Beginning several kilometers south of this point the walls on the western, outside bends of the meanders reveal the stratigraphic relationship between floodplain deposits and older valley fill (Figure 3.2, locus F). The oldest unit exposed in these walls is pink sand that is cemented and very hard, essentially lithified (Figure 3.6, unit F1). This deposit is likely equivalent to upper units of the St. David Formation representing the early to middle Pleistocene (Gray 1965; 1967). Overlying this at a sharp contact are floodplain deposits (Figure 3.6, unit F2) that consist of loose,
light to dark brown silts, fine sands and clays with a series of thin buried soil horizons. The upper unit, F2, contains isolated sherds throughout its vertical extent. Thus, the sequence here indicates that in some areas of the main stem river channel late Holocene floodplain sediments directly overlie ancient eroded Pleistocene surfaces, and sediments that span the Paleoindian era are absent (Figure 3.7).

Figure 3.5 St. David Fm exposed in river channel cut
Figure 3.6 Locus F stratigraphy

Figure 3.7 Locus F generalized stratigraphic cross-section
Western Valley

The western region of the valley includes several major tributary arroyos that run from west to east, draining the southern foothills of the Huachuca Mountains and intersecting the main stem San Pedro River in a perpendicular confluence. The topography of this area is characterized by several low hills, with a piedmont surface that slopes to the east toward the river channel. This sloping surface is apparently the Mexican extension of the Tombstone surface described by C.V. Haynes (1968). From north to south, tributary arroyos in the western zone include: El Tejano arroyo; El Tule arroyo; El Nogalar arroyo; and Las Nutrias, the primary western tributary of the San Pedro (Figure 3.2)

El Tejano arroyo (locus ET)

El Tejano is the northernmost major tributary arroyo in the western portions of the valley. The El Tejano drainage begins high in the Huachuca Mountains in Arizona, runs in a southeasterly direction, crossing the border at 31°120” N and 110°16’36” W at an elevation 4757 fasl (1450 masl), and continues due east to its confluence with the river channel at 31°17’41”N and 110°10’45”, 4347 fasl (1325 masl) elevation, roughly 5 kilometers south of the international border (Figure 3.2).

As it crosses the inner valley and approaches the river, El Tejano is a classic example of arroyo incision in arid western North America. In these lower stretches (Figure 3.2, locus ET) it is a wide, deeply incised arroyo with walls exposing stratigraphic exposures between 3-4m in height (Figure 3.8). The exposed deposits
consist of fluvial sands, silts and gravels with a sequence of four buried soil horizons. The lowermost unit (ET1) is brown silt to medium sand that contains a weakly expressed thin buried soil (Ab4/Bwb4) horizon in its basal portion. SOM humate and residue fractions from this soil produced ages of 3781+/43 $^{14}$C yr B.P. and 4,829+/72 $^{14}$C yr B.P. respectively (Figure 3.8, Table 1.1). Four radiocarbon ages from dispersed charcoal recovered above the buried soil horizon in this unit range from 3600 +/- 45 $^{14}$C years B.P to 3454 +/- 46 $^{14}$C yr B.P (Figure 3.8, Table 1.1). Unit ET1 is overlain by a 20-40 cm thick gravel layer (Unit ET2), which is, in turn, overlain by brown fluvial sands and silts (Unit ET3). Humate and residue fractions from a weakly expressed buried soil horizon (Ab3/Bwb3) in the lower portions of ET3 yielded ages of 2,448 +/- 40 $^{14}$C years B.P and 2,697 +/- 61 $^{14}$C years B.P., respectively (Figure 3.8, Table 1.1). SOM ages derived from the weakly expressed buried soil horizon (Ab2/Bwb2) at the top of unit ET3 are 1584 +/- 38 $^{14}$C years B.P on the humate fraction and 1620 +/- 60 $^{14}$C years B.P on the bulk residue fraction (Figure 3.8, Table 1.1). The overlying unit (ET4) consists of a fine sandy silt loam. Ages derived on the uppermost buried soil horizon (1Ab/1Btwb) are 380 +/- 37 $^{14}$C years B.P on the humate fraction and 533 +/- 40 $^{14}$C years B.P on the residue fraction (Figure 3.8, Table 1.1). The uppermost unit (ET5) consists of bedded silts and fine sands representing historic deposition.
Figure 3.8 Locus ET stratigraphy

Figure 3.9 Locus ET generalized stratigraphic cross-section
El Tejano remains the most comprehensively dated arroyo in the project area. Paired bulk residue and humate SOM ages from each of the four buried soil horizons and charcoal dates from unit ET1 are in relatively good agreement with each other and indicate four late Holocene periods of stability and pedogenesis. This sequence of buried soils is evident for ~4 kilometers upstream in El Tejano, at which point the arroyo becomes very shallow and wide. The alluvial sand and silt deposits pinch out, as do the buried soils and are replaced by a massive, uniform gravel layer. This gravel deposit is indiscernible from the gravels on the floor of the arroyo and on the surface of the surrounding hillslopes. This gravel is thought to represent the uppermost portions of the St. David Formation or the Nexpa gravels and is indicative of intense, widespread net erosion and lack of late Quaternary sediments. The characteristics and age of stratigraphic units underlying unit ET1 in the inner valley are unobserved and unknown, thus raising the possibility of deeply buried, early Holocene and late Pleistocene deposits in the lowest reaches of El Tejano arroyo (Figure 3.9).

*El Tule arroyo (locus TL)*

El Tule arroyo is the next arroyo to the south in the western portions of the valley. El Tule runs almost due east from the southern foothills of the Huachuca Mountains to its confluence with the river channel at 31°16’29”N,110°10’5”W, 4396 fasl (1340 masl), roughly 2.5 kilometers south of El Tejano (Figure 3.2, locus TL). Like El Tejano, the lower stretches of El Tule in the inner valley are wide and deeply incised, with walls and stratigraphic exposures 3-4 meters high. Unlike El Tejano, however, very ancient
deposits are evident in the basal sections of the stratigraphic exposures (Figure 3.10). The lowermost unit (TL 1) consists of red, calcareous, very hard silty sands and gravels. Overlying this is reddish brown gravelly sandy silt (unit TL 2) with a very well developed Btkb soil horizon. The upper units observed in El Tule arroyo (units TL 3 and 4) consist of brown fluvial silts and fine sands, with a weakly expressed A/Bwb soil horizon (Figure 3.10). The degree of weathering and expression of the upper buried soil horizon allows for a confident assessment the upper unit is of a late Holocene age. The cemented nature, extreme weathering, heavy clay and carbonate illuviation, and bright red color exhibited by the lowest deposits allows for a confident assignment to at least the late Pleistocene. Thus, in El Tule very recent late Holocene deposits are observed to be disconformably overlying very ancient Pleistocene deposits and it appears that deposits representing a large span of time that included the Paleoindian era are missing (Figure 3.11).

The stratigraphic sequence described above generally persists for ~2.5 kilometers upstream in El Tule arroyo. At this point a uniform massive gravel layer replaces both the lower and upper deposits. A thin layer of recent aeolian silt disconformably overlies this gravel deposit. Identical to the upper reaches of El Tejano, the massive gravels represent the uppermost portions the St. David Formation or the Nexpa gravels and are indicative of intense, widespread net erosion and lack of late Quaternary sedimentation and Paleoindian-age deposits.
Figure 3.10 Locus TL stratigraphy

Figure 3.11 Locus TL Generalized stratigraphic cross-section
El Nogalar arroyo (locus EN)

Four kilometers south of El Tule is El Nogalar arroyo (Figure 3.2, locus EN). Like El Tule, El Nogalar begins in the southern foothills of the Huachuca Mountains at (31°16’33”N, 110°18’16”W at an elevation of 5085 fasl (1550 masl) and runs due east for 12 kilometers to its confluence with the river at 31°13’53”N, 110°11’46”W at an elevation of 4412 fasl (1345 masl). The lower four kilometers of El Nogalar course through the relatively flat inner valley and the arroyo here is very shallow and wide. Statigraphic exposures in this stretch are seldom more than one meter deep and reveal brown to light brown fluvial sands silts and clays. The exposed deposits in the lower reaches of El Nogalar are late Holocene and correlate with the upper deposits observed in the headwaters region of the river.

Four to seven kilometers upstream from its confluence with the river channel, however, El Nogalar becomes much more deeply incised with stratigraphic exposures extending to heights of 3-4 meters (Figure 3.2, locus EN). The basal unit exposed in these areas (EN 1) is a very hard, cemented reddish brown gravel deposit (Figure 3.12). This unit is overlain by reddish brown calcareous sandy silt (unit EN 2), which is in turn, overlain at a by strong brown silty loam (unit EN 3). The top of this unit exhibits pedogenesis with buried Btb and Btkb soil horizons. An isolated groundstone fragment was observed in the lower Btkb horizon. The upper unit (EN 5) is loose fine sandy silts, apparently recent slopewash and aeolian deposition.
Figure 3.12 Locus EN stratigraphy

Figure 3.13 Locus EN Generalized stratigraphic cross-section
The groundstone observed in unit EN 3 allows for a confident assignment to the middle to late Holocene. However, the age of the underlying, lowermost units remains unknown. No organic materials suitable for radiometric determinations were observed in any of the lower units, nor were any index artifacts or fossils. It is possible that these units represent the late Pleistocene or early Holocene. However, pedestrian survey of 12 kilometers of El Nogalar failed to identify any evidence that would support such an assertion. If units EN 1 and EN 2 are in fact Holocene, then it is also possible that preserved Paleoindian-age deposits are deeply buried beneath the lowermost units in El Nogalar (Figure 3.13). However, in the absence of sub-surface probes there is currently no evidence with which to evaluate this possibility.

*Las Nutrias arroyo (locus LN)*

South of El Nogalar is the major western tributary of the San Pedro River known as Las Nutrias arroyo (Figure 3.2, locus LN). From where it joins El Sauz arroyo to form the main San Pedro River channel at 31°11′43″ N, 110°12′38″W, this arroyo extends roughly 35 km to the northwest to the international border and San Rafael Valley divide. In its lower seven kilometers, Las Nutrias is deeply entrenched with exposures up to three meters high. Stratigraphic deposits exposed in Las Nutrias consist of loose brown to light brown fluvial sands, silts and clays (Figure 3.14, units LN 1-3). Within unit LN2 are two weakly expressed buried soil horizons. These deposits very similar to deposits observed in the headwaters area and represent the late Holocene. Deposits underlying these units
have not been exposed by incision and therefore, their age and characteristics remain unknown (Figure 3.15).

Figure 3.14 Locus LN stratigraphy

Figure 3.15 Locus LN generalized stratigraphic cross-section
Seven kilometers upstream from the confluence with the main river channel, at 31°12’03”N, 110°16’38” an artificial dam has been constructed in the Las Nutrias channel to create a 4-5 acre stock tank. Upstream of this reservoir, Las Nutrias arroyo is not entrenched. The channel upstream is broad and shallow, lacking the type of incision necessary to expose underlying sediments. This shallow channel persists in both Las Nutrias and its dendritic tributary gullies throughout the extensive plains and rolling hill country that characterizes the far western portions of the study area.

South Central Valley

The south-central region of the valley is characterized by long, low, gently sloping ridges that extend northward from Sierra Mariquita and Sierra de Los Ajos toward the valley axis. El Riecito, which joins Las Nutrias and El Sauz to form the San Pedro River channel, is the primary northerly running tributary in this portion of the valley (Figure 3.2). Near the headwaters confluence El Riecito incises through late Holocene alluvial floodplain deposits described in the first section of this chapter. The underlying deposits are not exposed and, therefore, neither their age nor characteristics are known.

El Piojo (locus EP)

El Piojo arroyo begins in the Sierra Mariquita foothills extending to the northeast to its confluence with El Riecito (Figure 3.2, locus EP). The lowest reaches of El Piojo are deeply entrenched and provide relatively good stratigraphic exposures between
roughly 4500-5000 fasl (1370-1525 masl). The lowest unit exposed in this reach of El Piojo (Figure 3.16, unit EP 1) is very hard, cemented sandy clay loam with pebbles and gravel that is modified by pedogenesis, exhibiting a well expressed buried Bt/ka horizon. This unit is overlain by reddish brown silty sand and clays (unit EP 2). The upper unit (EP 3) consists of loose, bedded silts and sands that overlie unit EP2 at an abrupt erosional contact. The characteristics of EP3 indicate that it represents late Holocene deposition, while the lowest unit, EP 1, represents the late Pleistocene. The age of the middle unit, EP 2 is, however, somewhat equivocal. No index artifacts or fossils were observed in this unit, nor was any material suitable for radiometric determinations recovered. Based on its color and characteristics, it appears that EP 2 may represent the late Pleistocene. If this is the case, the sharp erosional contact exhibited between EP 2 and EP3 suggests that the Paleondian-age deposits are missing in this area (Figure 3.17). However, assigning EP 2 to the Pleistocene is tentative at best and the possibility remains that this unit is in fact early to middle Holocene.

Figure 3.16 Locus EP stratigraphy
Arroyo Claro (loci AC and AC2)

Arroyo Claro extends from Sierra de los Ajos and runs in a northerly direction to its confluence with El Riecito (Figure 3.2). Massive gravel deposits characterize the upper stretches of Arroyo Claro. This area has been the site of extensive commercial gravel quarry operations that have destructively altered the entire stretch of Arroyo Claro that occurs above 4650 fasl (1417 masl). In its lower reaches, below 4600 fasl, Arroyo Claro incises through undisturbed stratigraphic deposits (Figures 3.2, loci AC and AC2). The upper lithological units exposed in Arroyo Claro (Figure 3.18, units AC 2-4 and Figure 3.19, unit 2AC2,) consist of brown fluvial silts, sands and gravels. Unit AC 3 exhibits pedogenesis with one Ab1/Bwb1 horizon at 105-125 cmbs, and a lower buried Ab2/Bwb2 horizon at 175-205 cmbs. The upper units, AC 2-4, overlie, at a sharp erosional contact, a lower very hard red sandy loam (Figure 3.18, unit AC 1; Figure 4.19, unit 2AC1).
Figure 3.18 Locus AC stratigraphy

Figure 3.19 Locus AC2 stratigraphy
Radiocarbon ages on SOM from the lower buried soil horizon in unit AC3 (Ab2/Bwb2) are 538+/−37 ¹⁴C years B.P on the humate fraction and 887+/−38 ¹⁴C years B.P on the base insoluble residue fraction (Figure 3.18, Table 1.1). These two ages are in relatively good agreement with each other and are supported by two overlying charcoal dates. Charcoal at 170 cmbs yielded a radiocarbon age of 323+/−40 ¹⁴C years B.P, while charcoal recovered from 127 cmbs yielded a radiocarbon age of 176+/−40 ¹⁴C years B.P. (Figure 3.18, Table 1.1). The characteristics of the lowest deposits, unit AC1, such as the bright red color and extremely hard cementation allow for a confident determination that this unit represents the late Pleistocene. The prominent disconformity exhibited between the upper units, AC 2-4 and 2AC2, and the lower units, AC 1 and 2AC1, is thus indicative of an absence of Paleoindian-aged deposits (Figure 3.20). The disconformable
relationship between the upper and lower units described above is more or less continuous for 8-10 kilometers in Arroyo Claro before its confluence with El Riecito.

_Arroyo Seco (locus LM, site AZ:EE16:5)_

Arroyo Seco is the next arroyo east of Arroyo Claro (Figure 3.2, AZ:EE:16:5). Like Arroyo Claro, Arroyo Seco begins in the Sierra de los Ajos and flows northward to El Riecito. Yet, unlike Arroyo Claro, Arroyo Seco has not been the site of commercial gravel quarry operations. The stratigraphy exposed in the lower reaches of Arroyo Seco is very similar to the units exposed in Arroyo Claro described above. However, the very upper reaches of Arroyo Seco contain patches of preserved late Quaternary deposits (Figure 3.21, AZ:EE:16:5). These remnants occur as isolated terraces on the flanks of the very upper reaches of Arroyo Seco in the foothills region of Sierra de los Ajos in the vicinity of 4880 fasl (1487 masl). The stratigraphy here consists of an upper unit of bedded silts and sands (unit LM 3), which is underlain by sandy silts with some randomly dispersed gravels and gravel lenses (unit LM 2). The lowest unit exposed consists of a thick layer of silt loam (unit LM 1), the top of which exhibits pedognenesis in the form of a buried Btk soil horizon.

This area is considered especially significant as local ranchers report finding a Clovis point at site AZ:EE:16:5, described earlier, located along the flanks of Arroyo Seco. Unit LM 2 contains isolated groundstone and flakestone artifacts. SOM radiocarbon ages from the Btkb horizon in units LM 1 are 1823+/-40\(^{14}\)C years B.P on the humate fraction and 1987+/-39 \(^{14}\)C years B.P on the base insoluble residue (Figure 3.21,
Table 1.1). As the depth of incision has not exposed the underlying units, their age and characteristics remain unknown (Figure 3.22). It seems possible that there are deeply buried intact Paleoindian-age deposits in this area. This possibility is even more likely in light of the Clovis archaeology reported from site AZ:EE:16:5.

Figure 3.21 Locus LM/site AZ:EE:16:5 stratigraphy
The eastern portions of the valley situated south of Sierra San Jose contain El Sauz arroyo, one of the primary tributaries of the San Pedro River. El Sauz has a dendritic pattern with numerous tributaries of its own. Most of the low-order tributaries begin in the foothills south of Sierra San Jose and the main channel of El Sauz runs due west for roughly 30 kilometers, joining El Riecito and Las Nutrias at 31°11’43” N, 110°12’38”W to form the San Pedro River channel (Figure 3.2, locus ES). For nearly the entire extent of its length El Sauz is a deeply entrenched gully, with some portions exhibiting steep walls four meters or more in height.
The oldest deposit revealed in the lower reaches of El Sauz (Figure 3.2, locus ES) in its lower reaches is dark brown red, hard silty sand loam with some pebbles (Figure 3.23, unit ES1). Overlying this is a brown silty clay loam (unit ES 2). Isolated sherds are contained in uppermost portions of unit ES2. The upper portions of unit ES 2 exhibits weathering and pedogenesis, characterized by a weakly expressed Btw horizon. Radiocarbon ages of SOM derived from the 3Btb horizon are $1446 \pm 38$ $^{14}$C years B.P on the humate fraction and $1095 \pm 38$ $^{14}$C years B.P on the bulk residue fraction (Figure 3.23, Table 1.1). While it is unusual for humate fractions to date later than bulk residue fractions, the two ages are in relatively good agreement with each other. Unit ES 2 is overlain by a reddish brown loose fine sandy loam (unit ES 3). The upper portions of which contain a truncated moderately well developed Btkb soil horizon (Btkwb2). Overlying this is very loose, brown fine sandy silt (unit ES 4), which is, in turn overlain by poorly sorted, angular sandy gravel (unit ES 5). ES 5 is disconformably overlain by a thin silt layer (unit ES 6) that exhibits slight pedogenesis and a poorly expressed Bwb soil horizon. Figure 3.24 details the generalized stratigraphic relationships observed in the lower stretches of El Sauz drainage.

The age of the lowest deposit, unit ES1, observed in lower stretches of El Sauz arroyo remains unknown. In over 10 kilometers of pedestrian survey in the lower stretches of El Sauz, the dark reddish brown basal sands were not observed to contain any artifacts or index fossils that would give a clue to its age. Nor was this unit observed to contain any organic material suitable for radiometric determinations. Roughly eight kilometers upstream from its confluence with the main river channel this lowest unit
ceases to appear in exposures as it is positioned lower than the depth of incision. For 7-9 kilometers upstream of this area, the lowest observed deposit is unit ES2.

Figure 3.23 Locus ES stratigraphy

Figure 3.24 Locus ES generalized stratigraphic cross-section
The sequence of buried soil horizons described above persists in El Sauz arroyo, more or less continually for more than 15 kilometers upstream. In the upper reaches of El Sauz arroyo, downstream of Via Verde reservoir, arroyo incision reveals very ancient deposits (Figure 3.2, locus V). In this exposure, the basal unit (Figure 3.25, unit V1) is a light reddish brown, very hard, almost lithified, calcareous clay loam with a reddish brown buried Btkb soil horizon. The characteristics of this unit and the expression of the buried Btkb horizon allows for a confident determination that this unit is late Pleistocene or older. Overlying V1 at a clear erosional contact is reddish brown sandy silt (unit V2) that is also at least as old as the late Pleistocene. Overlying V2 at an abrupt erosional contact is the upper unit (unit V3) that consists of a silt loam with two buried soil horizons (Figure 3.25). Isolated sherds eroding out of the Ab2/Btwb2 horizon demonstrate a late Holocene age for unit V3. The prominent erosional disconformity exhibited between late Holocene unit V3 and underlying Pleistocene deposits, V1 and V2, indicates that Paleoindian aged deposits are absent in the El Sauz drainage in the vicinity of Via Verde (Figure 3.26).

At 31°08′37″N and 109°59′54″W, a dam has been constructed to create the 7-9 acre Via Verde reservoir. Upstream of this impoundment, El Sauz drainage is characterized by numerous tributary gullies arranged in a dendritic pattern among low hills and ridges. Incised gullies 2-3 kilometers upstream of reservoir reveal (Figure 4.2, locus AV) a similar stratigraphic sequence to that observed downstream of the dam. The stratigraphy here (Figure 3.17) consists of an upper unit (Figure 3.27, unit AV3) comprised of brown sands and silts with a buried A/Btwb soil horizon. The expression
Figure 3.25 Locus V stratigraphy

Figure 3.26 Locus V generalized stratigraphic cross-section

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and degree of weathering exhibited by this soil indicate that it is from the late Holocene. Unit AV 3 is resting unconformably on red, very hard, cemented sandy clay loam with pedogenesis characterized by a buried red Btkb horizon (Figure 3.27, unit AV 2). The expression of this lowest buried soil allows for a confident determination that it is late Pleistocene or earlier. The prominent erosional contact displayed between the lowest deposits and the upper late Holocene deposits again indicates that the Paleoindian-age deposits are missing in this area (Figure 3.28).
An incision nickpoint occurs at 31°10’36"N, 109°57’38" at an elevation of 5085 fasl (1550 masl). Numerous shallow gullies persist above the nickpoint extending to the east of Ejido Cuauhtemoc and site AZ:FF:13:7 (Figure 3.2). Surface erosion in this area is much more dramatic than that observed the lower reaches of El Sauz. Large surface areas in the vicinity of Rancho Las Cruces reveal tan clay with dispersed pebbles (Figure 2.15, unit LC 2). This tan clay unit contains the fossilized remains of *Mamuthus, Equus* and *Camelops* at site AZ:FF:13:7. Gully exposures at Rancho Las Cruces in the vicinity show the fossil bearing clay resting on purple silt stone bedrock (Figure 2.15, unit LC1). Overlying fossil bearing LC2 in some areas is a red argillic sandy silt loam, also of a Pleistocene age. Several small gullies at Rancho Las Cruces have exposures that reveal remnant patches of an uppermost unit that consists of a thin relict Bt horizon.
Taxonomic analyses that are discussed in depth in Chapter 2 indicate that the fossil remains in the tan clay belong to the early Rancholabrean land mammal age. This unit, therefore, is related either to the St. David Formation (Gray 1965; 1967) or the Millville alluvium (Haynes 1987). As with other exposures in the El Sauz drainage, the erosional contact evident in the upper portions of this Pleistocene unit is indicative of severe erosion and/or a lack of sedimentation and missing Paleoindian-age deposits (Figure 3.29).

La Coja and Casas Viejas arroyos (locus E)

The eastern valley also includes La Coja arroyo and Casas Viejas arroyo. Both of these arroyos run almost due west from Sierra San Jose, intersecting the river in a
perpendicular fashion near Ejido San Pedro. The deeply incised lower reaches of both arroyos exhibit similar stratigraphic sequences (Figure 3.2, locus E). The oldest deposit observed in La Coja and Casas Viejas consists of calcareous sandy loam (Figure 3.30, unit E1). The upper portions of this unit exhibit heavily weathered and very well expressed buried Btkb horizon (Btkb3). This is truncated and overlain at a clear contact by red sandy gravels (Figure 3.30, unit E2). Resting on the red gravel unit at an abrupt contact is hard sand to silt loam (Figure 3.31, unit E3) with a well-expressed buried Btkb horizon. Groundstone and flakestone artifacts diagnostic of the San Pedro horizon of the late Archaic (Justice 2002) occur on top of this buried soil horizon. The upper deposits consist of sands and silts with a buried A/B horizon.

The diagnostic San Pedro phase artifacts indicate that the upper units are definitely late Holocene. Based on color, expression and degree of weathering, the lower red units are at least as old as the late Pleistocene. The large disconformity exhibited between the old and young deposits indicates a high degree of erosion that removed a large amount of late Pleistocene and early Holocene deposits. It thus appears that in this area there is a widespread disconformity that indicates the absence of Paleoindian-age deposits (Figure 3.31). It must be noted, however, that in the very lowest reaches of each arroyo, as they cross the inner valley floodplain, the underlying deposits are not exposed. Their age and characteristics, therefore, remain unknown.
Figure 3.30 Locus E stratigraphy

Figure 3.31 Locus E generalized stratigraphic relationship
North of Sierra San Jose (site AZ:EE:12:5)

The region north of Sierra San Jose is a broad pediment surface that gently slopes downward to the north as it approaches the international border. The surface of this pediment exhibits heavy erosion, probably due to a loss of vegetation as a result of overgrazing. The pediment surface is primarily composed of bright red erosional gravels that are likely equivalent with the upper portions of the St. David Formation (Gray 1965; 1967) or the Nexpa gravels (Haynes 1987). Late Quaternary sediments inset into these deposits are exposed in several northerly running draws and arroyos and are best characterized at site AZ:EE:12:5 (Figure 3.2; Figure 2.10).

The oldest late unit exposed in these profiles is light reddish brown pebbly sandy clay loam with (Figure 2.10, unit P1) that exhibits heavy clay translocation and iron and manganese staining. Overlying this is unit P2, a calcareous clay loam that contains heavily fossilized proboscidean remains at site AZ:EE:12:5. The upper portion of P2 contains a bright red, truncated buried Btkb horizon (Figure 2.10). This unit is overlain at a sharp erosional contact by brown alluvial silts, sands and clays (Figure 2.10, unit P4). Two buried soil horizons occur in these upper deposits. The lowermost of these is a buried Ab2/Btb2 horizon at 95-115 cmbs. The upper buried soil consists of a silty A/Btwb horizon at 38-75 cmbs (Figure 2.10).

While no organic components suitable for radiocarbon dating are preserved, the bright red color and expression of the Btkb3 horizon overlying the elephant remains indicate that it is at least as old as the late Pleistocene. Overlying the Pleistocene deposits at a sharp contact, radiocarbon ages of SOM from the buried Ab2/Btb2 horizon are
1601+/− 39 $^{14}$C years B.P on the base insoluble residue fraction and 2517+/−46 $^{14}$C years B.P on the humate fraction (Figure 2.10, Table 1.1). Radiocarbon ages of SOM from the upper buried soil horizon are 866+/−38 $^{14}$C years B.P on the residue fraction and 1552+/−38 $^{14}$C years B.P. on the humate fraction (Figure 2.10, Table 1.1). In the cases of both radiocarbon-dated buried soil horizons, humate fractions dated significantly older than the residue fractions. While this is unusual, the older humate dates are deemed to give a better minimum age of stability and soil formation. The fossil remains contained within unit P1 are identifiable to the order proboscidea. Despite the lack of species-specific characteristics, stratigraphic position below a buried Pleistocene soil and the heavily mineralized nature of the remains suggests that they are in excess of ~25,000 years (C. Vance Haynes personal communication; Richard White personal communication).

The fossil bearing deposit at AZ:EE:12:5 may be equivalent with the Millville formation (unit Qmi) identified by C.V. Haynes (1987), or it may be an older fossil bearing St. David unit. For the purposes of the current investigation the salient issue is that the fossilized remains are clearly too ancient for, and demonstrably lack, associated artifacts. Further, the chronostratigraphy in the alluvial deposits north of Sierra San Jose demonstrates a prominent erosional disconformity between the underlying Pleistocene deposits and upper late Holocene deposits (Figure 3.32). Severe erosion has evidently removed an assuredly large amount of late Quaternary sediments. Upstream from the fossil locale, the stratigraphy in the east wall of the arroyo reveals a late Holocene channel that has incised into unit P2 and is filled with loose, cross-bedded sands and silts (Figure 3.33). Paleoindian-age sediments are apparently missing from alluvial deposits
found in the area of the valley that occurs on the pediment surface north of Sierra San Jose.
Upper Greenbush Draw (locus GB)

The upper reaches of Greenbush Draw are located southeast of Naco, Sonora. This area is a broad alluvial plain that has been intensively overgrazed, and has a marked lack of grasses or forbs. The only vegetation present is diffusely scattered, stunted mesquite, with individual trees typically less than one meter high. The surface in this area exhibits severe erosion and is generally composed of red gravels. Several small tributary gullies dissect this region exposing the underlying alluvial deposits.

Where late Quaternary deposits are exposed in the gullies of upper Greenbush Draw, distinctive deposits can be traced over large areas of the alluvial plain. This sequence is best represented by the stratigraphic profile exposed in the walls of arroyo La Cruz (Figure 3.2). La Cruz arroyo (Figure 3.34) begins in the piedmont surface to the east of Sierra San Jose at 31°15′42″N, 109°57′10″ and flows to the northeast. In its upper stretches this arroyo courses through red Pleistocene gravel deposits. The channel of arroyo La Cruz is deeply incised between 31°17′27″N/109°55′49″E and 31°18′44″N/109°55′27″E (Figure 3.2, locus GB), as it runs through an elevation range of roughly 4700-4800 fasl (1425-1460 masl). Downstream from here, the channel of La Cruz widens and becomes very shallow and ceases to incise as it nears modern agricultural fields and erosion control features in the vicinity of Naco.

The oldest stratigraphic deposit exposed in the deeply incised portions of arroyo La Cruz consists of very hard, cemented, bright red sandy clay loam with some pebbles (Figure 3.35, unit GB 1). Unit GB1 exhibits pedogenesis characterized by a very well
expressed Btkb horizon. Based on the expression of this deposit, it certainly is at least as old as the late Pleistocene. The top of this unit exhibits an erosional surface that is overlain by reddish yellow silty clay loam (Figure 3.35, unit GB 2). The entire unit is modified by pedogenesis comprised of a truncated Btb (Btkb2) horizon. This is disconformably overlain by a 50 cm thick pink gravel layer (Figure 3.35, unit GB 3). GB 3 is disconformably overlain by light brown sandy silt loam with some pebbles and gravels. The top of this unit has a truncated Btb (Btb1) horizon. The uppermost unit (Figure 3.35, unit GB5) is loose unconsolidated sandy silt. Based on weathering and pedogenic characteristics similar to radiocarbon dated buried soil horizons in others regions of the project area, it can be confidently stated that the upper deposits represent the late Holocene. The erosional disconformity exhibited between these units and the underlying Pleistocene deposits indicates that Paleoindian-aged deposits have been removed by erosion in the upper reaches of Greenbush Draw. The Clovis aged deposits, Antev’s (1953) beds e and d from the Naco site, were not identified in the upper reaches of Greenbush Draw in Mexico. This area, however, has yielded several Paleoindian artifacts to residents of Naco that are described in the previous section (Figure 3.2, points 1 and 2). These enigmatic finds might be indicative of deeply buried or spatially restricted patches of Paleoindian-age deposits preserved in this area that have yet to be identified.
Figure 3.34 Arroyo La Cruz overview

Figure 3.35 Locus GB stratigraphy
Summary

In summary, alluvial sequences exposed in the arroyos of the upper San Pedro basin of Mexico are varied and complex. However, the results of this investigation allow for several generalizations that are useful for evaluating the nature of preservation of Paleoindian-age deposits. Thick sequences of late Holocene alluvium are preserved in the inner basin along the valley axis (Figure 3.2, locus HW), in the western portions of the valley in arroyos such as Las Nutrias and El Tejano (Figure 4.2, loci ET and LN). In many of these areas the underlying deposits are not exposed, therefore raising the possibility of preserved deeply buried latest Pleistocene and early Holocene deposits in the inner basin. However, in exposures such as in El Tule, and Arroyo Claro (Figure 3.2, loci TL, AC and AC2), as well as exposures in the main river channel (Figure 3.2, locus...
F), where the relationship between late Holocene alluvium and the underlying deposits is observable, a prominent erosional contact is evident between upper late Holocene units and underlying Pleistocene strata. This disconformity indicates a high degree of scouring and/or lack of deposition that has resulted in the absence of Paleoindian-aged deposits in many areas. The presence of fossilized remains of extinct megafauna at or near the surface in the outer valley in the Ejido Cuauhtemoc vicinity (Figure 3.2, site AZ:FF:13:7) and north of Sierra San Jose (Figure 3.2, site AZ:EE:12:5) demonstrates either a high degree of late Pleistocene/early Holocene degradation and/or a lack of sedimentation in these areas as well. Thin late Holocene deposits overlie Pleistocene fossil bearing units north of Sierra San Jose, and in the eastern valley flanks, again indicating the absence of Paleoindian-aged deposits. In the southern outer margins and upland flanks of the valley such as in the upper reaches of Arroyo Seco (Figure 3.2, site AZ:EE:16:5), patches of late Quaternary alluvium are preserved. Diagnostic artifacts found by local residents in this area present the possibility of, as of yet unidentified, intact Paleoindian deposits in this area. An ambiguous situation occurs in the sequences revealed in the depths of El Piojo arroyo, El Nogalar arroyo and the low reaches of El Sauz (Figure 3.2, loci EP, EN and ES). In all of these arroyos there are deposits that remain undated. While soil horizons in the upper units of these arroyos allow for a confident assignment to the late Holocene, the underlying deposits have neither material suitable for radiometric determinations, nor any other characteristics that would provide a clue as to their age. The possibility therefore remains that these deposits are of late Pleistocene or early Holocene age. However, no artifacts, features or fossils that would support such an assertion were
encountered. Despite extensive pedestrian survey, nowhere in the valley of Mexico were unequivocal Paleoindian-age deposits identified. Likewise the widely recognizable late Pleistocene deposits, the Black Mat and Coro Marl, as well as Antev’s (1953) beds d and e, known from the valley in Arizona, were not identified in the valley on Mexican territory.
CHAPTER 4: DISCUSSION, IMPLICATIONS & CONCLUSION

Archaeological implications

The artifacts recorded by this study stand as the first documented evidence of a Paleoindian occupation in the portions of the upper San Pedro Valley in Sonora. In the absence of intact sites and stratigraphic deposits of the proper time frame, these specimens provide the most reliable evidence of Paleoindian utilization of the valley south of the border and add several details to our knowledge of the Paleoindian occupation of the region at large. Because our knowledge of Paleoindian peoples is as yet so limited, even the kinds of information that to be gained from these isolated occurrences are valuable contributions to our understanding of these ancient people.

The quartz crystal material of the La Mula fluted basal fragment is similar to three quartz crystal fluted points known from the Lehner site (Haury et al. 1959). The only obvious difference is that the Lehner specimens are smaller. Haury et al. (1959:15) attribute the small size of the Lehner points to raw material constraints. However, the maximum width of the extremely well crafted La Mula point is 28 mm (Appendix B), making it slightly larger than the mean maximum width of 26.44 mm reported for all fluted points from Arizona (North et al. 2005: 301).

The use of high quality lithic materials with aesthetic qualities is well-established for early Paleoindian peoples (e.g. Collins 1990; Gramly 1993; 2000; G. Haynes 2002; Wilke et al. 1991). The use of quartz crystal to manufacture projectile points appears to have been important to Clovis folks in the Greater Southwest region, as well as the upper San Pedro. In addition to the Lehner specimens, several quartz crystal fluted points are
known from Northwest Mexico. Manuel Robles (1974) reports an isolated quartz crystal Clovis point from the central coast of Sonora (Figure 4.1). The El Bajio site north of Hermosillo yielded an isolated quartz crystal fluted point from the surface (Guadalupe Sanchez personal communication). Recent investigations by the author have also documented several quartz Clovis points in collections from the vicinity of Hermosillo.

Figure 4.1 Quartz crystal fluted point central coast of Sonora (Univ. of Sonora Museum collections)

Figure 4.2 Quartz crystal fluted point from Hermosillo vicinity (Hermosillo collections)
Several quartz crystal sources occur both in and around the upper San Pedro basin. In addition to the quartz crystal sources identified in the upper valley in Mexico as part of this investigation, local Arizona hunting guide and CRM archaeologist Gaylon Tinsley (personal communication) reports a source of quartz crystal in the Hauchuca Mountains with individual crystals large enough to manufacture a point similar in size to the La Mula specimen.

The late Paleoindian artifacts identified as part of this study are significant additions to the scant evidence of human adaptations of this time period in the valley. While the location of the source remains unknown, the Plainview specimen found southeast of Naco is made of macroscopically identical lithic raw material to a Plainview point recovered in Sabino Canyon near Tucson by Old Pueblo Archaeology Center. A black basalt projectile point recovered by Lou Escapule in the 1960s from the surface in the Schaldack vicinity in Arizona bears remarkable similarities to Dalton technology known from the Southeast U.S. (Huckell 1982). Until now this specimen has been extremely enigmatic. However, the recent documentation of several complete projectile points that exhibit similar morphological traits in the vicinity of Hermosillo provides additional evidence of a presumably late Paleoindian or early Archaic Dalton-like technology in the region (Figure 4.4). These specimens are the first clues of what might turn out to be a previously unrecognized early Holocene adaptation in the borderlands region of Northern Sonora.
The variety of lithic sources identified in the valley in Mexico may indicate that early Paleoindian peoples in the San Pedro had a greater degree of landscape familiarity than previously believed. At the excavated San Pedro valley Clovis sites, most of the artifacts are made of several varieties of chert whose sources remain obscure (Haury 1953; Haury et al. 1959; Hemmings 1970; Huckell 1982; 2004). Samples from the recently identified lithic sources in Mexico appear macroscopically similar to several of the chert varieties present in Clovis assemblages in the valley. One petrified wood projectile point tip in the Murray Springs assemblage appears similar to material from the Petrified Forest National Forest and has been taken as evidence of a north to south line of travel by a Clovis band from the area near Holbrook (Huckell 2004). However, the material of the Murray Springs specimen is also macroscopically similar to samples of petrified wood from the recently identified source in the Mexican portions of the basin thus presenting the possibility of a Clovis utilization of this source of tool stone. A word of caution is in order. Macroscopic source studies are equivocal at best. Appearance alone is not a reliable guide in determining the source of lithic raw materials (Herz 2001).
However, the presence of these lithic sources presents the possibility that Clovis people responsible for the sites in Arizona obtained some of their lithic raw materials in the San Pedro Valley of Mexico.

**Intra-Valley Stratigraphic Correlations**

Intra-valley stratigraphic correlations with thoroughly studied and well-known late Quaternary sections from the valley in Arizona (e.g. Antevs 1953; Haury et al. 1959; C.V. Haynes 1968; 1987) provide the most reliable means of evaluating the nature of preservation of Paleoindian-age alluvial deposits in the upper San Pedro Valley of Mexico.

Radiocarbon ages of soil horizons allow for the widespread correlation of pedostratigraphic units throughout the San Pedro Valley of Mexico and correlations with alluvial sequences known from the U.S. portions of the valley. Utilizing soils for stratigraphic correlations such as this is one of the more common geoarchaeological approaches (e.g. Holliday 1989; 1995; 1997; 2004). The uppermost buried soil identified in the project area in Mexico is referred to as soil unit I followed (highest to lowest) by soils II, III, and IV (Table 4.1)

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<td>II</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ab2</td>
<td>Bwb2</td>
<td>1584+/-38</td>
<td>~</td>
<td>~</td>
<td>Ab2</td>
</tr>
<tr>
<td>III</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ab3</td>
<td>Bwb3</td>
<td>2448+/-40</td>
<td>~</td>
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</table>
The charcoal and SOM radiocarbon ages from dated late Holocene sequences in the basin in Mexico (Tables 1.1 and 4.1) allow for correlation with the McCool alluvium (Qmc) and Hargis alluvium (Qha) defined by C.V. Haynes (1987) as the upper two members of the Escapule Formation (Qes). Radiocarbon ages of the sequence of four late Holocene buried soil horizons identified in Mexico correlate well with four radiocarbon-dated buried soil horizons in the Escapule Formation. The Hargis alluvium (Qha) contains two buried soil horizons with dates of ~4000-3600 BP, and ~3000-2400 BP respectively (C.V. Haynes 1987), which correlate with soil units III and IV identified in the valley in Mexico. The upper McCool alluvium has two buried soil horizons, one from ~2000-1200 BP and one at ~500 BP (C.V. Haynes 1987), which correlate with soil horizons II and I identified in Mexico. Thus, it is readily demonstrable that the upper units identified in Mexico are equivalent to the upper two (Qmc and Qha) members of the Escapule (Qes) Formation (C.V. Haynes 1987). While there are no radiocarbon dates available from Greenbush Draw, it can be stated with reasonable confidence that the late Holocene units identified in Mexico correlate in part or in whole with Antevs’(1953) three upper units (f, g and h) at the Naco site.

Fossilized remains of extinct megafauna allow for biostratigraphical correlations with well-known Pleistocene sequences from the U.S. portions of the valley. While the extinct proboscidean remains from site AZ:EE:12:5 are of an indeterminate species, their stratigraphic occurrence beneath a buried Pleistocene soil horizon indicates that the
fossil-bearing strata can be correlated with either the Milville (Qmi) Formation (C.V. Haynes 1987) or the upper members of the St. David Formation (Gray 1965; 1967). The *Mammuthus imperator* remains at AZ:FF:13:7 demonstrate that the site’s fossil-bearing units are equivalent to the upper members of the St. David Formation. While these deposits are thought too ancient to have associated artifacts, the biostratigraphical correlations are significant in the fact that they document the preservation and exposure of Pleistocene stratum in the upper San Pedro south of the border.

Related late Holocene, as well as early to middle Pleistocene units are thus seen to be readily identifiable and traceable throughout the entire upper basin. Yet, distinctive early Holocene and late Pleistocene Paleoindian-aged deposits that are common in the Arizona portions of the valley remain unknown in the San Pedro in Mexico (Table 4.2).

Table 4.2 Intra-Valley Stratigraphic Comparisons

![Table 4.2 Intra-Valley Stratigraphic Comparisons](image)
Most immediately apparent is the absence of distinctive Paleoindian-age deposits, such as the famous Black Mat, known from Clovis sites in the valley in Arizona (C.V. Haynes 1987). Antev’s (1953) beds d and e, which are the mammoth- and artifact-bearing units at the Naco site, also have not been identified in the Mexican portions of the basin. None of these distinctive Paleoindian-age deposits, nor chronologically equivalent units, have been identified in the valley south of the border despite extensive survey in virtually all of the river’s major tributary arroyos. Also found to be absent from the Mexican portions of the basin are late Pleistocene deposits such as the Coro Marl (Qco), early Holocene deposits such as the Donnet silt (Qdo), and middle Holocene deposits such as the Weik Ranch alluvium (Qwk).

**Inter-Valley Stratigraphic Correlations**

The absence of identified Paleoindian-age deposits in the Mexican portions of the San Pedro is quite different than the Arizona side of the valley where complete late Pleistocene and early Holocene sequences are preserved in places such as Curry Draw and Lehner Ranch. The nature of preservation of late Pleistocene deposits in the valley south of the border is, however, similar to other drainage basins in the region (Table 4.3). The adjacent Santa Cruz and Cienega Creek Valleys have experienced substantial erosion that removed all sediments older than 5000 BP. The Tonto Basin contains no deposits older than 3500 BP (Waters 1986; 2000).
Geoarchaeological Assessment

The potential for intact Paleoindian sites in the upper San Pedro Valley of Sonora hinges upon the preservation of alluvial deposits of a terminal Pleistocene/early Holocene age. The absence of identified Paleoindian-age deposits could be due to one of two reasons. The first possibility is that deposits of this age are completely missing from the valley in Mexico; either they were never deposited or were completely removed by erosion. The second possibility is that deposits of this age are present in the valley in
Mexico yet remain unidentified due to extremely deep burial or geographically limited occurrence.

In exposures in the project area where the relationship between the upper and lower alluvial deposits is observable, a widespread erosional disconformity is evident between the upper late Holocene units and underlying Pleistocene deposits. This disconformity is most evident at paleontological locales identified as part of this project. The stratigraphy at AZ:EE:12:5 reveals a buried soil horizon that dates to ~1600 BP immediately overlying a buried late Pleistocene soil horizon formed on a deposit containing extinct elephant remains. Based on radiocarbon ages coupled with biostratigraphy, the chronostratigraphic sequence here thus reveals a missing gap of at least ~ 24,000 years. At site AZ:FF:13:7, remains of *Mammuthus imperator* are in a deposit that occurs either at the surface or is immediately overlain by a sherd-bearing cultural strata. These index fossils and artifacts demonstrate a chronostratigraphic gap with more than 100,000 years missing. This prominent disconformity appears throughout the project area. As described in Chapter 3, this erosional contact is evident in arroyos from each of the geographic zones. This widespread disconformity exhibited between ancient underlying Pleistocene units and upper, late Holocene deposits is a testament to the a lack of deposition and/or a substantial degree of erosion that has affected the upper reaches of the valley during the late Quaternary, scouring out and removing an assuredly large amount of sediments. It seems that this erosion removed late Pleistocene and early Holocene deposits and *in situ* Paleoindian remains from large portions of the valley in Mexico.
However, in many portions of the inner basin along the valley axis there occur thick late Holocene deposits. In some areas the underlying units are not exposed. Therefore, the possibility of patches of deeply buried late Pleistocene deposits in the inner valley cannot be ruled out. In assessing this possibility, it is well worth noting that there is a significant section of El Tejano arroyo, with a basal date of ~ 4000 B.P. that occurs ~4 meters beneath ground surface. This indicates a very high amount of sedimentation and/or relatively low amount of erosion over the past 4000 years, thus hinting at the possibility of deeply buried older sediments. Resolution of this question demands a strategy of subsurface probing including coring, augering, and trenching. If deeply buried Paleoindian aged sediments are discovered to occur in the San Pedro of Mexico it would indicate that the river channel was deeply incised at times during the late Pleistocene and/or early Holocene.

Regardless of these possibilities, in terms of geomorphology, the tangible result of this study is the finding that there is variable preservation and exposure of late Pleistocene and early Holocene alluvial deposits throughout the upper San Pedro basin. The alluvial stratigraphy of Curry Draw (Murray Springs) is described in numerous publications (e.g. C.V. Haynes 1987; Waters 2000; Waters and Haynes 2001), usually as a composite for the entire Upper San Pedro. In actuality, however, the Black Mat blankets only half of the excavated early Paleoindian sites in the basin. The results of the current investigation demonstrate either the absence or lack of exposure of Paleoindian aged deposits in the upper San Pedro of Mexico. This variation in preservation and exposure of alluvial deposits found throughout the upper basin should not be considered
surprising. In many cases in alluvial systems in the arid west, it is difficult or impossible to extend stratigraphic correlations for any appreciable distance up or downstream (Ferring 2001).

This brings us to the question of why this is the case. While this issue is currently irresolvable, it is possible to begin to address the question by reviewing the factors that control the alluvial environments of the San Pedro: climate and climate changes and internal geomorphic adjustments (Bull 1991; Brown 1997; Knox 1983; Ritter et al. 1995; Schumm 1977; Waters 2000).

Climatic factors controlling alluvial cycles have long been recognized and are well established in the case of the Upper San Pedro (e.g. Antevs 1953; 1955; 1959; Melton 1965; C.V. Haynes 1968; 1987). Climate and climate changes are thought to have been responsible for episodes of deposition and erosion and stability and arroyo cutting and filling throughout the Quaternary (e.g. C.V. Haynes 1987; Waters and Haynes 2001). Climate is a regional phenomenon. Due to close proximity and relatively similar elevations, the present-day climate is the same in the Arizona and Mexico portions of the upper valley (USDA and AZ Water Commission 1977). There is no reason to think that the case would be otherwise during any period of prehistory. However, in the arid West, rapid changes in an alluvial system that do not correspond to climate change are common (Ferring 2001). The exact manner in which climate operates on and affects an alluvial system can vary throughout a basin, due to specific internal geomorphic variables, localized responses and adjustments (Butzer 1982; Ferring 2001; Schumm 1973; 1977; Patton and Schumm 1981; Waters 1992; 2000).
Cycles of deposition, erosion and stability within alluvial systems are controlled by a general external factor and a complex variety of localized geomorphic variables. This means that a simple change in one of a variety of external factors (i.e. runoff, vegetation, sediment size, slope) can produce a complex series of events that in turn cause a variety of changes (Schumm 1973; 1977; Patton and Schumm 1981). The low-order tributaries that characterize the upper San Pedro are most susceptible to local geomorphic factors and individual complex responses unique to each particular arroyo. Moreover, the arroyos, which are essentially ephemeral streams with “flashy” discharge, found in the upper San Pedro are inherently unstable (Bull 1991). It is possible that each arroyo in the upper basin is operating according to its own unique set of geomorphic variables exhibiting, in essence, its own particular stratigraphic sequence.

Erosion plays a key role in the preservation and exposure of Paleoindian-age deposits in the Upper San Pedro. Erosion and arroyo cutting transport sediment out of a drainage basin in an episodic manner in which sediment that is eroded as the nickpoint recedes upstream is trapped in the widened channel downstream (Schumm 1973; 1977). This process results in erosional stretches of the channel separated by stable channel or aggrading reaches. This means that if there is deposition in one spot of the drainage, then there must be erosion somewhere else, and vice versa. Dissection may begin downstream, or along a higher order stream, centuries earlier than it does upstream, or in a lower order valley (Butzer 1982; Patton and Schumm 1981). The result of this process is differential preservation and erosion of sediments in different tributary arroyos in the same drainage basin, a situation like that found in the upper San Pedro.
We may never know for certain the precise causes of the differential preservation of Paleoindian-age deposits throughout the upper basin. However, for the purposes of the current investigation, the salient issue is that late Pleistocene/early Holocene aged deposits have not been identified in the upper San Pedro Valley of Sonora. As geologic deposits of the appropriate age are unknown, so too have there been no *in situ* Paleoindian remains identified in the Upper San Pedro of Sonora.

### Conclusion

Much has been written on the remarkable preservation of late Pleistocene and early Holocene deposits in the upper San Pedro and the fact that this valley contains the densest concentration of mammoth-kill sites in the New World (e.g. C.V. Haynes 1987; G. Haynes 2002; Waters 1991; 2000; Huckell; 1982; 2004). While this certainly is the case in reaches of the basin that occur between the international border and Fairbank, the preservation of late Pleistocene and early Holocene deposits is neither uniform nor ubiquitous throughout the upper basin. No Paleoindian-age deposits have been identified in the basin north of St. David, and deposits of this time period remain unknown from the portions of the upper basin south of the border in Sonora, Mexico. In evaluating the findings of this investigation, it is best to keep in mind the old adage: the absence of evidence is not evidence of absence. While late Pleistocene and early Holocene deposits are demonstrably missing throughout large areas, the possibility remains that there are patches of deeply buried, as of yet unidentified Paleoindian-age deposits preserved in the Mexican portions of the upper valley. Irrespective of this consideration, the fact remains
that despite intensive, systematic survey, Paleoindian-age deposits, and likewise, unequivocal, *in situ* Paleoindian sites remain unknown from the upper San Pedro Valley of Sonora, Mexico.

These findings demonstrate that the well-known complete late Quaternary sequences reported from Clovis sites in Arizona such as the Black Mat and Coro Marl are restricted to relatively small areas of the upper basin. Site AZ:EE:16:5 may be found to contain intact Paleoindian archaeology and isolated artifacts documented as part of this investigation are significant in the fact that they are testimony that Paleoindian peoples utilized the portions of the San Pedro Valley that occur south of the border in Mexico. However, in the absence of identified alluvial deposits of the appropriate timeframe in much of the upper valley of Mexico, evaluating the intensity of this occupation is problematic. It seems unlikely that the cluster of stratified Paleoindian sites in Arizona represents a unique, intensive use of the portions of the valley that occur in the vicinity of Sierra Vista and Naco. Instead this record undoubtedly reflects biases imposed by different intra-valley geological processes and variable preservation and exposure of Paleoindian-age deposits. A similar level of Paleoindian activity probably occurred within the valley in Sonora. However, in the absence of known buried sites, there is no way to ascertain this for certain. Future investigations focused on this issue would do well to employ a strategy of sub-surface probing in the floodplain deposits of the main river channel, or in the major tributary arroyos as they cross the inner valley, to determine if there are in fact deeply buried Paleoindian-age deposits preserved in the upper San Pedro Valley of Sonora, Mexico.
**APPENDIX A: DESCRIPTIONS AND AGES OF STRATIGRAPHIC UNITS**

### San Pedro Headwaters and River Channel

**Locus:** HW-San Pedro Headwaters

<table>
<thead>
<tr>
<th>Unit</th>
<th>Max Thickness (cm)</th>
<th>Description</th>
<th>Soil Hoz</th>
<th>Age</th>
</tr>
</thead>
<tbody>
<tr>
<td>HW4</td>
<td>45</td>
<td>sandy silt, light yellow brown (10YR 6/4), thinly bedded silts and fine to coarse sands, very loose, unconsolidated; gradational contact</td>
<td>~</td>
<td>latest Holocene</td>
</tr>
<tr>
<td>HW3</td>
<td>95</td>
<td>silt and fine sand, light brown (7.5YR 6/3) laminated silt and fine sand, loose; pedogenesis and weathering--series of buried soil horizons--silt loam, brown (7.5YR 4/3) weakly expressed, fine blocky subangular to angular structure, slightly hard peds; gradational contact</td>
<td>Ab1 Bwb1 Ab2 Bwb2</td>
<td>late Holocene&lt;sup&gt;c&lt;/sup&gt;</td>
</tr>
<tr>
<td>HW2</td>
<td>110</td>
<td>fine sand and silt, brown (7.5YR 5/4), horizontally bedded fine sand and silt, massive structure, slightly hard; gradational contact</td>
<td>~</td>
<td>late Holocene&lt;sup&gt;c&lt;/sup&gt;</td>
</tr>
<tr>
<td>HW1</td>
<td>75</td>
<td>silty clay, brown(7.5YR 5/2); moderately developed fine to medium prismatic structure, hard peds, cienega deposition</td>
<td>Btwb2</td>
<td>late Holocene (?)</td>
</tr>
</tbody>
</table>

**Locus:** F- River Channel

<table>
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<th>Age</th>
</tr>
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<tbody>
<tr>
<td>F2</td>
<td>150</td>
<td>silt loam, brown (7.5YR 5/3-4/3) to dark grey brown (10YR 4/2-3/2) loose, single-grained to laminated; pedogenesis and weathering series of buried soil horizons, weakly developed, fine blocky angular structure, clay skins, mod. hard peds, abrupt contact</td>
<td>Ab1 Bwb1 Bwb2</td>
<td>late Holocene&lt;sup&gt;b&lt;/sup&gt;</td>
</tr>
<tr>
<td>F1</td>
<td>250</td>
<td>sand, pink(7.5YR 7/3), coarse sand with ~20% pebbles, very hard, cemented (lithified)</td>
<td>~</td>
<td>Pleistocene&lt;sup&gt;b&lt;/sup&gt;</td>
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### Western Valley

**Locus:** ET- El Tejano

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</thead>
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<td>ET5</td>
<td>45</td>
<td>sandy silt, brown (7.5YR 4/4); thinly bedded fine sand and silt; loose; unconsolidated; massive structure; gradational contact</td>
<td>~</td>
<td>latest Holocene (&lt;500 yr BP)</td>
</tr>
<tr>
<td>Unit</td>
<td>Max Thickness (cm)</td>
<td>Description</td>
<td>Soil Hoz</td>
<td>Age</td>
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</tr>
<tr>
<td>ET4</td>
<td>75</td>
<td>fine sandy silt loam, brown (7.5YR 5/2-4/3); pedogenesis in upper unit—buried desert Ab and Bwb soil horizon, weakly developed, fine blocky angular structure; thin (&lt;10cm) poorly sorted subangular pebbles distributed in lower portion of unit; clear contact</td>
<td>Ab1 Bwb1</td>
<td>late Holocene (&lt;1000-500 yr BP)</td>
</tr>
<tr>
<td>ET3</td>
<td>125</td>
<td>sandy silt loam brown (7.5YR 5/4); bedded medium to fine sand and silt with 15% subangular pebbles; pedogenesis and weathering—series of Ab and Bwb buried soil horizons—weakly expressed granular to fine blocky subangular structure, slightly hard peds; clear contact</td>
<td>Ab2 Bwb2 Ab3 Bwb3</td>
<td>late Holocene (&lt;2700-1500 yr BP)</td>
</tr>
<tr>
<td>ET2</td>
<td>30</td>
<td>sandy gravel, pink (7.5YR 7/3); very poorly sorted coarse sands and subangular gravels, massive structure, clear contact</td>
<td>~</td>
<td>late Holocene (&lt;3400-2700- yr BP)</td>
</tr>
<tr>
<td>ET1</td>
<td>150</td>
<td>sandy silt, light brown (7.5YR 64/-4/4); fine to medium sandy silt with ~10% pebbles and small discontinuous gravel lenses; pedogenesis and weathering—buried Ab and Bwb soil horizon—weakly expressed granular structure, slightly hard peds</td>
<td>Ab4 Bwb4</td>
<td>late Holocene (&lt;4800-3400 yr BP)</td>
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**Locus:** TL- El Tule

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<tr>
<td>TL4</td>
<td>25</td>
<td>sandy silt, brown (7.5YR 4/4); thinly bedded fine sand and silt; loose, unconsolidated; massive structure; gradational contact</td>
<td>~</td>
<td>latest Holocene</td>
</tr>
<tr>
<td>TL3</td>
<td>55</td>
<td>fine sandy silt loam, brown (7.5YR 5/2-4/3); pedogenesis and weathering in upper portion of unit—buried desert Ab and Bwb soil horizon-- weakly developed fine blocky angular structure; thin (&lt;10cm) discontinuous poorly sorted subangular pebble lenses at bottom of unit; abrupt contact</td>
<td>Ab1 Bwb1</td>
<td>late Holocene&lt;sup&gt;a&lt;/sup&gt;</td>
</tr>
<tr>
<td>TL2</td>
<td>115</td>
<td>sandy silt loam with some (5-10%) pebbles and cobbles, reddish brown (5YR 4/4), pedogenesis in upper portion of unit—well developed fine to medium columnar structure, clay skins, CaCo3 coating on peds, very hard peds; gradual contact</td>
<td>Btkb2</td>
<td>Pleistocene (?)&lt;sup&gt;b&lt;/sup&gt;</td>
</tr>
<tr>
<td>TL1</td>
<td>100</td>
<td>silty sand and gravels, reddish brown (5YR 5/4), massive structure, very hard, cemented</td>
<td>~</td>
<td>Pleistocene&lt;sup&gt;b&lt;/sup&gt;</td>
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**Locus: EN- El Nogalar Arroyo**

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<tbody>
<tr>
<td>EN4</td>
<td>10</td>
<td>fine sandy silt, brown (7.5YR 5/3) thinly bedded fine sandy silt, very loose; gradational contact</td>
<td>~</td>
<td>late Holocene</td>
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<tr>
<td>EN3</td>
<td>50</td>
<td>silty loam, brown (7.5YR 4/3), moderately well developed fine blocky subangular to prismatic structure, slightly hard peds, moderate clay skins, CaCO3 coatings on peds; clear contact</td>
<td>Btb1 Btkb2</td>
<td>middle (?) to late Holocene</td>
</tr>
<tr>
<td>EN2</td>
<td>45</td>
<td>sandy silt, reddish brown (2.5YR 5/4); poorly sorted silt to medium sand, massive structure, heavy CaCo3, very hard; gradual contact.</td>
<td>~</td>
<td>?</td>
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<tr>
<td>EN1</td>
<td>60</td>
<td>sandy gravels, reddish brown (2.5YR 3/4), very poorly sorted angular and subangular gravels with some medium sand, massive structure; weakly cemented</td>
<td>~</td>
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**Locus: LN- Las Nutrias**

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<tr>
<td>LN3</td>
<td>60</td>
<td>sandy silt, light yellow brown (10YR 6/4), thinly bedded silts and fine to coarse sands, loose, unconsolidated; gradational contact</td>
<td>~</td>
<td>latest Holocene</td>
</tr>
<tr>
<td>LN2</td>
<td>100</td>
<td>silt and fine to coarse sand, light brown (7.5YR 6/3) laminated silt and sand, loose, unconsolidated; pedogenesis and weathering--series of Ab/Bwb soil horizons--silty clay loam, brown (7.5YR 4/3) weakly expressed, fine blocky subangular structure, hard peds, slight clay illuviation; clear contact</td>
<td>Ab1 Ab2 Bwb1 Bwb2</td>
<td>late Holocene</td>
</tr>
<tr>
<td>LN1</td>
<td>110</td>
<td>fine sand and silt, brown (7.5YR 5/4), horizontally bedded fine sand and silt, massive structure, slightly hard</td>
<td>~</td>
<td>late (?) Holocene</td>
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</table>
### South Central Valley

**Locus:** EP-El Piojo Arroyo

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<th>Age</th>
</tr>
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<tbody>
<tr>
<td>EP3</td>
<td>70</td>
<td>sandy silt, brown (7.5YR 5/3) bedded fine sand and silt, loose, unconsolidated; pedogenesis and weathering--buried Bw soil hoz--sandy loam, brown (7.5YR 4/3) weakly expressed coarse granular structure; soft peds, very abrupt contact</td>
<td>Bwb</td>
<td>late Holocene&lt;sup&gt;a&lt;/sup&gt;</td>
</tr>
<tr>
<td>EP2</td>
<td>65</td>
<td>silty sand with some (~10-15%) pebbles, reddish brown (5YR 4/3), poorly sorted v. coarse to medium sand with some silt, discontinuous subangular poorly sorted pebble lenses, light CaCO₃ fingers, hard; clear lower boundary</td>
<td>~</td>
<td>?</td>
</tr>
<tr>
<td>EP1</td>
<td>60</td>
<td>sandy clay loam with some (~15%) pebbles and cobbles, reddish brown (2.5YR 4/4) with discontinuous pebble and cobble lenses in bottom portion of unit; pedogenesis and weathering throughout unit-medium to coarse columnar structure, very hard peds, CaCO₃ fingers, clay skins</td>
<td>Btkb2</td>
<td>Pleistocene&lt;sup&gt;b&lt;/sup&gt;</td>
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</table>

**Locus:** AC/AC2-Arroyo Claro

<table>
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<th>Unit</th>
<th>Max Thickness (cm)</th>
<th>Description</th>
<th>Soil Hoz</th>
<th>Age</th>
</tr>
</thead>
<tbody>
<tr>
<td>AC4</td>
<td>35</td>
<td>sandy silt, light brown (7.5YR 6/3), single-grained to thinly bedded silt and fine sand, loose, unconsolidated; very abrupt contact</td>
<td>~</td>
<td>historic&lt;sup&gt;c&lt;/sup&gt; (~&lt;176 years BP)</td>
</tr>
<tr>
<td>AC3</td>
<td>75</td>
<td>fine sandy to silty clay loam, brown (10YR 5/3), bedded silts and fine sands; pedogenesis and weathering--series of Ab Bwb buried soil horizons--dark gray brown (10YR 4/2) weakly expressed, fine blocky subangular, slightly hard peds; gradational contact</td>
<td>Ab1 Abw1 Ab2 Abw2</td>
<td>latest Holocene&lt;sup&gt;a&lt;/sup&gt; (~887 to 176 yr BP)</td>
</tr>
<tr>
<td>AC2</td>
<td>150</td>
<td>sandy silt with some (~15%) pebbles and cobbles, brown (10YR 5/3); very poorly sorted silty medium sand and subangular pebbles and cobbles, fining upward, massive structure, unconsolidated; very abrupt contact</td>
<td>~</td>
<td>late (?) Holocene&lt;sup&gt;b&lt;/sup&gt;</td>
</tr>
<tr>
<td>AC1</td>
<td>75</td>
<td>loamy sand with some (~10%) pebbles, red (2.5YR 4/6), massive structure, uniformly dispersed poorly sorted pebbles, very hard matrix, manganese staining, CaCO₃ fingers, clay skins</td>
<td>~</td>
<td>Pleistocene&lt;sup&gt;b&lt;/sup&gt;</td>
</tr>
</tbody>
</table>
**Locus: Arroyo Seco/AZ:EE:16:5**

<table>
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<th>Description</th>
<th>Soil Hoz</th>
<th>Age</th>
</tr>
</thead>
<tbody>
<tr>
<td>LM3</td>
<td>60</td>
<td>sandy silt with some (~15%) gravels, brown (7.5YR 4/4), bedded silts and fine to medium sands; poorly sorted subangular pebbles and small cobbles distributed throughout matrix, loose, unconsolidated; clear contact</td>
<td>~</td>
<td>late Holocene</td>
</tr>
</tbody>
</table>

| LM2  | 100                | silt to coarse sand and gravels (15%), brown (7.5YR 4/4); bedded silts and medium to coarse sands; subangular pebbles and cobbles distributed throughout matrix and discontinuous gravel lenses; hard; massive structure; very abrupt contact | ~ | late Holocene |

| LM1  | 85                 | silt clay loam, dark gray brown (10YR 4/2) with white (7.5YR 8/1) CaCO3 coatings; pedogenesis and weathering throughout unit--well developed fine columnar structure; heavy clay illuviation; heavy Ca CO3 coatings and stringers | Btkb | late Holocene (?) to ~1900 yr BP |

**Eastern Valley**

**Locus: ES- El Sauz Arroyo, lower reach**

<table>
<thead>
<tr>
<th>Unit</th>
<th>Max Thickness (cm)</th>
<th>Description</th>
<th>Soil Hoz</th>
<th>Age</th>
</tr>
</thead>
<tbody>
<tr>
<td>ES6</td>
<td>45</td>
<td>sandy silt with some (5-10%) pebbles and cobbles, brown (7.5YR 4/4), loose, unconsolidated; pedogenesis and weathering in upper portions of unit--buried Bwb soil horizon--sandy loam, brown (7.5YR 5/5) weakly expressed angular structure, soft peds, very little apparent clay or CaCO3 illuviation; clear contact</td>
<td>Bwb</td>
<td>latest Holocene</td>
</tr>
</tbody>
</table>

<p>| ES5  | 20                 | sandy gravel, light brown (7.5YR 6/3); unconsolidated, single grained, very poorly sorted coarse sands and gravels; clear contact | ~ | late Holocene |</p>
<table>
<thead>
<tr>
<th>Unit</th>
<th>Max Thickness (cm)</th>
<th>Description</th>
<th>Soil Hoz</th>
<th>Age</th>
</tr>
</thead>
<tbody>
<tr>
<td>ES4</td>
<td>25</td>
<td>very fine sandy silt, brown (7.5YR 4/4) moderately sorted very fine sandy silt, massive structure, loose; abrupt contact</td>
<td>~</td>
<td>late Holocene</td>
</tr>
<tr>
<td>ES3</td>
<td>75</td>
<td>fine sandy loam, dark red brown (5YR 3/4); pedogenesis and weathering--buried soil horizon--dark red brown (5YR 3/3) weakly to moderately expressed fine blocky subangular, clay skins, CaCO3 fingers on peds (white 5YR 8/1), mod hard peds; gradational contact</td>
<td>Btkw2</td>
<td>late Holocene</td>
</tr>
<tr>
<td>ES2</td>
<td>65</td>
<td>silty clay loam; dark red brown (7.5YR 3/3); some (~10%) fine to medium sand in lower portions of unit; pedogenesis and weathering in upper portions of unit--buried Btw hoz--moderately expressed blocky angular to prismatic structure, moderate clay skins, hard peds; gradational contact</td>
<td>Btwb3</td>
<td>late Holocene</td>
</tr>
<tr>
<td>ES1</td>
<td>50</td>
<td>silty sand loam; dark red brown (5YR 3/4); poorly sorted medium to coarse sands; some (~10%) cobbles; very hard, massive structure</td>
<td>~</td>
<td>Pleistocene (?)</td>
</tr>
</tbody>
</table>

**Locus:** V-El Sauz Arroyo below Via Verde
### Locus: AV-El Sauz arroyo above Via Verde

<table>
<thead>
<tr>
<th>Unit</th>
<th>Max Thickness (cm)</th>
<th>Description</th>
<th>Soil Hoz</th>
<th>Age</th>
</tr>
</thead>
<tbody>
<tr>
<td>AV3</td>
<td>80</td>
<td>sandy silt, brown (7.5YR 5/3), bedded fine to coarse sands and silts, loose, single grained; pedogenesis and weathering in upper portions of unit--buried silty loam desert A and Bt hoz--dark red gray (5YR 4/2) moderately well expressed fine blocky subangular structure, moderately hard peds, some clay skins; gradational contact</td>
<td>Ab1 Btb1</td>
<td>late Holocene&lt;sup&gt;b&lt;/sup&gt;</td>
</tr>
<tr>
<td>AV2</td>
<td>100</td>
<td>fine sandy clay loam, light reddish brown (5YR 6/4); buried soil hoz in uppermost portion of unit--reddish brown (5YR 4/4) sandy clay loam, well developed columnar structure; very hard peds; heavy clay skins; moderately heavy CaCO3 fingers and coatings; gradual contact</td>
<td>Btkb2</td>
<td>Pleistocene&lt;sup&gt;b&lt;/sup&gt;</td>
</tr>
<tr>
<td>AV1</td>
<td>150</td>
<td>sandy clay loam with some (~15-20%) pebbles and cobbles, light reddish brown (5YR 6/4); very poorly sorted, massive structure, very hard, cemented, manganese staining, moderate CaCO3 fingers</td>
<td>~</td>
<td>Pleistocene&lt;sup&gt;b&lt;/sup&gt;</td>
</tr>
</tbody>
</table>

### Locus: AZ:FF:13:7

<table>
<thead>
<tr>
<th>Unit</th>
<th>Max Thickness (cm)</th>
<th>Description</th>
<th>Soil Hoz</th>
<th>Age</th>
</tr>
</thead>
<tbody>
<tr>
<td>LC4</td>
<td>45</td>
<td>silty clay loam, dark red gray (2.5YR 3/1), pedogenesis and weathering-relict Bt horizon- moderately well expressed fine blocky angular structure, slightly hard peds; clear contact</td>
<td>relict Bt</td>
<td>late Holocene&lt;sup&gt;c&lt;/sup&gt;</td>
</tr>
<tr>
<td>LC3</td>
<td>50</td>
<td>sandy silt loam with some pebbles (15%), red (2.5YR 4/6), poorly sorted medium to fine sandy silt loam with 15% angular to subangular pebbles; gradational contact</td>
<td>~</td>
<td>Pleistocene&lt;sup&gt;b&lt;/sup&gt;</td>
</tr>
<tr>
<td>LC2</td>
<td>145</td>
<td>sandy clay loam with some (~10%) pebbles, light brown (7.5YR 6/4) to brown (7.5YR 4/4), fine sandy clay loam with ~10% poorly sorted angular pebbles, very hard, heavy manganese staining, some CaCO3 fingers and coatings; clear contact</td>
<td>~</td>
<td>Pleistocene&lt;sup&gt;g&lt;/sup&gt;</td>
</tr>
<tr>
<td>LC1</td>
<td>145</td>
<td>siltstone bedrock, weak red (7.5YR 5/4); completely lithified siltstone</td>
<td>~</td>
<td>Pleistocene&lt;sup&gt;b&lt;/sup&gt;</td>
</tr>
</tbody>
</table>
**Locus:** E- La Coja and Casas Viejas arroyos

<table>
<thead>
<tr>
<th>Unit</th>
<th>Max Thickness (cm)</th>
<th>Description</th>
<th>Soil Hoz</th>
<th>Age</th>
</tr>
</thead>
<tbody>
<tr>
<td>E5</td>
<td>20</td>
<td>silty sand with some (~10%) pebbles, dark red brown (5YR 3/4-4/4); silty coarse to medium sands with 10% subangular pebbles, very poorly sorted, loose, unconsolidated single grained structure; clear contact</td>
<td>~</td>
<td>late Holocene</td>
</tr>
<tr>
<td>E4</td>
<td>45</td>
<td>fine sandy silt loam, reddish brown (5YR 4/4); pedogenesis and weathering in upper portions of unit--buried A and Bt hoz--moderately well developed blocky angular to prismatic structure; moderately hard peds; moderate clay skins; gradational contact</td>
<td>Ab</td>
<td>late Holocene</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Bwb</td>
<td></td>
</tr>
<tr>
<td>E3</td>
<td>45</td>
<td>sand to silt loam, reddish brown (5YR 4/4); fine sandy to silt loam, buried soil hoz--well developed blocky subangular structure, hard peds, clay skins, moderate CaCO3 fingers; clear contact</td>
<td>Btkb2</td>
<td>late Holocene</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>E2</td>
<td>25</td>
<td>sandy gravels, red (2.5YR 4/6); very poorly sorted coarse sands and subangular gravels, massive structure, cemented; clear contact</td>
<td>~</td>
<td>?</td>
</tr>
<tr>
<td>E1</td>
<td>75</td>
<td>sandy loam, reddish brown (2.5YR 4/4); medium to fine sandy loam, poorly sorted, pedogenesis and weathering-buried Btk soil horizon-well developed prismatic structure, clay skins, CaCO3 fingers</td>
<td>Btkb3</td>
<td>Pleistocene^5(?)</td>
</tr>
</tbody>
</table>

**North of Sierra San Jose**

**Locus:** A-Z:EE:12:5

<table>
<thead>
<tr>
<th>Unit</th>
<th>Max Thickness (cm)</th>
<th>Description</th>
<th>Soil Hoz</th>
<th>Age</th>
</tr>
</thead>
<tbody>
<tr>
<td>P4</td>
<td>60</td>
<td>fine sandy silt, light red brown (5YR 6/4) to strong brown (7.5YR 4/6); poorly sorted fine sandy silt, loose; unconsolidated, single grained; clear contact</td>
<td>~</td>
<td>late Holocene</td>
</tr>
<tr>
<td>P4b</td>
<td>125</td>
<td>sandy silt, light red brown (5YR 6/4), gully fill, cross bedded fine to coarse sands and silts, loose, unconsolidated; very abrupt contact overlying unit P2</td>
<td>~</td>
<td>late Holocene</td>
</tr>
</tbody>
</table>
P3  55  silt loam, brown (7.5YR 5/3) to dark red brown (5YR 3/4); pedogenesis and weathering—series of buried soil horizons—brown (7.5YR 4/3) moderately developed fine blocky angular to prismatic structure; moderately hard peds; light clay skins; clear contact  

P2  145  clay loam with some (~10%) angular pebbles, red (2.5YR 3/6); upper portion of unit modified by pedogenesis—buried Btkb horizon—well developed medium prismatic structure; heavy clay skins, heavy CaCO3 fingers; gradual contact  

P1  100  fine sandy clay loam with some (~20%) coarse sands and pebbles and cobbles, red (2.5YR 4/6); very poorly sorted, angular pebbles and cobbles, fining upward; columnar structure; very hard peds; heavy clay coatings; heavy manganese staining; some CaCO3 fingers

Upper Greenbush Draw

<table>
<thead>
<tr>
<th>Locus: GB-Arroyo La Cruz</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Unit</strong></td>
</tr>
<tr>
<td>GB5</td>
</tr>
<tr>
<td>GB4</td>
</tr>
<tr>
<td>GB3</td>
</tr>
<tr>
<td>GB2</td>
</tr>
<tr>
<td>------</td>
</tr>
<tr>
<td>GB1</td>
</tr>
</tbody>
</table>

AGE DETERMINATIONS: ^a=radiocarbon determinations; ^b=relative age assignment based on characteristics, expression, and degree of weathering; ^c=sherd bearing strata, ^d=groundstone bearing strata, ^e=diagnostic San Pedro phase artifacts; ^f=Proboscidean bearing deposit; ^g=Mammuthus imperator bearing deposit; ^h=correlation with radiocarbon dated deposit
For comparative purposes, Paleoindian projectile points identified during this study were documented by the author following the guidelines outlined by previous fluted point studies in the Arizona/Sonora region (e.g. Huckell 1982; North et al. 2005). Qualitative recording consisted of a traced drawing and digital photo of each specimen. Quantitative documentation consisted of recording a comprehensive set of attributes for each specimen. The metric attributes such as length, maximum width (max w), basal width (bw), and maximum thickness (max t) were always documented, while attributes such as fluting flake lengths on each side (fl A/B), extent of grinding on the basal portion (bs grnd) and each margin (grnd: A/B) and depth of basal cavity (bcd) were recorded if applicable. Each specimen was weighed to the tenth of a gram. Table B.1 details the attributes of diagnostic Paleoindian projectile points identified in the San Pedro of Sonora.

Table B.1 Metric Attributes of Paleoindian Points

<table>
<thead>
<tr>
<th>Point #</th>
<th>Fluted</th>
<th>Fluted length</th>
<th>max w</th>
<th>bw</th>
<th>max t</th>
<th>fl: A</th>
<th>fl: B</th>
<th>bcd</th>
<th>Grnd:A</th>
<th>grnd:B</th>
<th>bs grnd</th>
<th>wt (g)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Y</td>
<td>bas frag 22.7</td>
<td>28.3</td>
<td>23.8</td>
<td>7</td>
<td>21.1</td>
<td>&gt; 21.1</td>
<td>3.3</td>
<td>21.5</td>
<td>total</td>
<td>total</td>
<td>5.1</td>
</tr>
<tr>
<td>2</td>
<td>Y</td>
<td>bas frag 27.6</td>
<td>27.3</td>
<td>23.9</td>
<td>6.6</td>
<td>total</td>
<td>17.6</td>
<td>4.3</td>
<td>total</td>
<td>total</td>
<td>total</td>
<td>5.7</td>
</tr>
<tr>
<td>3</td>
<td>BT*</td>
<td>bas frag 24.9</td>
<td>18.8</td>
<td>18</td>
<td>5.1</td>
<td>total</td>
<td>2.4</td>
<td>11.8</td>
<td>14.4</td>
<td>total</td>
<td>3.25</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>BT*</td>
<td>bas frag 12.7</td>
<td>19.4</td>
<td>19.4</td>
<td>4.4</td>
<td>total</td>
<td>2.9</td>
<td>total</td>
<td>total</td>
<td>total</td>
<td>1.3</td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>BT*</td>
<td>bas frag 22.2</td>
<td>21.1</td>
<td>18.8</td>
<td>4</td>
<td>total</td>
<td>1.1</td>
<td>total</td>
<td>total</td>
<td>total</td>
<td>2.25</td>
<td></td>
</tr>
<tr>
<td>7</td>
<td>Y</td>
<td>39.9</td>
<td>22.7</td>
<td>22.1</td>
<td>6.1</td>
<td>total</td>
<td>15.1</td>
<td>15.9</td>
<td>total</td>
<td>total</td>
<td>~</td>
<td></td>
</tr>
</tbody>
</table>

BT *designates basally thinned specimen
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