Late Paleoindian Occupations at the Genevieve Lykes Duncan Site, Brewster County, Texas

William A. Cloud, Richard W. Walter, Charles D. Frederick, and Robert J. Mallouf

The Center for Big Bend Studies of Sul Ross State University has been documenting and investigating archaeological sites since 1999 on the 02 Ranch in Brewster and Presidio counties, Texas. One of over 500 sites discovered, the Genevieve Lykes Duncan site,1 has deeply buried cultural deposits with intact thermal features dating to the Late Paleoindian period. The site was tested with hand-excavated units and backhoe trenches from 2010 through 2012, and radiocarbon data from the features indicate it is the earliest dated site in the greater Big Bend region by some 1,300 years. Notably, two plant-food preparation technologies ubiquitous across North America in the subsequent Archaic period—the use of stones as heating elements and use of groundstone implements—are well represented within the Late Paleoindian deposits. Findings from the testing phase at the site, including feature, artifact, and geoarchaeological data, are provided.

1. Genevieve Lykes Duncan, a matriarchal figure of the Lykes family and strong supporter of the Center’s work on the 02 Ranch, passed away in 2010. The site reported here was named after her to honor her love and passion for the ranch.
Introduction
In New Mexico over 80 years ago, archaeologists uncovered evidence that humans coexisted with extinct megafauna (e.g., mammoths and giant bison) in North America at the end of the Pleistocene epoch (Howard 1935a, 1935b; Wormington 1957). This discovery stimulated archaeological research into “Early Man” across the continent. Now referred to as “Paleoindians,” these early nomadic peoples lived in a time known archaeologically as the Paleoindian period (ca. 11,500–6500 B.C./13,500–8500 B.P.). Lacking evidence to the contrary, archaeologists assumed Paleoindians were the “First Americans” and this remained the paradigm for many years. The initial discoveries in New Mexico prompted archaeologists throughout the Americas to search for sites of similar antiquity. In the Big Bend region of Texas the hunt for early sites began in the 1930s and continues to this day. However, despite this lengthy period, sparingly few Paleoindian sites with buried and intact deposits have been discovered. Regional research into this time period was recently reinvigorated with discovery of a buried Late Paleoindian (ca. 10,000–6500 B.C./12,000–8500 B.P.) site on the 02 Ranch in west-central Brewster County—the Genevieve Lykes Duncan (GLD) site (41BS2615) (Cloud and Mallouf 2011; Cloud 2012).

Paleoindian Research in the Big Bend
In the Big Bend region of Texas the search for Paleoindian sites began with a noteworthy and innovative multidisciplinary project in the mid- to late-1930s involving both archaeologists and geologists. Undertaken well before the advent of radiocarbon dating, the project (the Peabody-Sul Ross Expedition) was designed to create a framework for understanding the interrelationship between sediments and past humans across the region, including Paleoindians (Albritton and Bryan 1939; Kelley et al. 1940). While intact Paleoindian sites were not discovered during the project, the researchers developed a stratigraphic model

2. B.P. is the acronym for “before present.” It denotes a time scale used in archaeology and other scientific disciplines to reference when events occurred in the past. It is used in radiocarbon dating and standard practice is to use January 1, 1950, as the “present” or origin of this age scale.
3. Now accepted by most archaeologists is evidence of even earlier occupants from across the Americas indicating that Clovis culture (the first “Paleoindians”) likely developed in the continental United States from an antecedent group. Radiocarbon data from a handful of North and South American archaeological sites indicate human occupations from 1,000 to 2,000 years earlier than Clovis (Waters and Stafford 2013).
Late Paleoindian Occupations at the Genevieve Lykes Duncan Site

that postulated an erosional period thought to date to the Pleistocene-Holocene transition. This marked the beginnings of Paleoindian research in the Big Bend.

Using the 1930s’ empirically based stratigraphic model, archaeologists working in the Big Bend have for years systematically searched arroyo cuts for buried Paleoindian sites to shed light on this poorly known period (Mallouf 2001); however, prior to discovery of the GLD site, almost all “Paleoindian finds” in the vast region came from the surface and most of these were single, isolated points lacking associated deposits (Seebach 2011). The dearth of known regional sites of this antiquity is likely related to several factors: 1) a presumed low population during the Paleoindian period and a concomitant low number of sites; 2) inaccessible, deeply buried deposits (Mallouf 1999:56); 3) an intense drought known as the Altithermal during the Early and Middle Archaic periods (ca. 7500–4000 B.P.) that triggered widespread erosion (Antevs 1955:320); and 4) the lack of regional large-scale construction projects requiring state and federally mandated archaeological investigations. Thus, the sites were probably few in number from the beginning, many were buried deeply by alluvial deposits, others were undoubtedly damaged or completely destroyed during the Altithermal, and few have been discovered through the archaeological investigations that have occurred. Although there are only a handful of known Paleoindian sites in the region, findings from two of the more noteworthy ones—the Chispa Creek Folsom site and the J. Charles Kelley site—are provided below, and are followed by a synopsis of the Late Paleoindian period in Trans-Pecos Texas.

Joe Ben Wheat discovered the Chispa Creek Folsom site on the Marfa Plain north of Valentine, Texas, in 1946 (Lehmer 1958; Lindsay 1969; Seebach 2004). He found numerous Folsom projectiles and scrapers on its surface and ultimately conducted excavations at the site in the 1960s, working through the University of Colorado Museum. In 2002, some 35 years after Wheat’s last efforts at the site, Southern Methodist University’s (SMU) John D. Seebach investigated the site through the QUEST Archaeological Research Fund (Seebach 2004). While Wheat had proposed the Folsom materials were in a primary context, Seebach indicated there were contextual problems with the archaeological materials, stating the site “is a single, very large, palimpsest of prehistoric occupation over the last 12,000 years. . . . It is much more likely aeolian deflation is uncovering artifacts from Folsom, as well as later, occupations and scattering them across the locale” (Seebach 2004:22–23). Thus, despite the strong Folsom presence at the site, the deposits may lack the integrity needed to preserve cultural features and other aspects of human behavior.
It was not until the early 1990s that a buried and securely dated Paleoindian site was discovered in the region. Identified during construction activities for a new ranger station in Big Bend National Park’s Chisos Basin by then Park Archeologist Thomas C. Alex, the site was named the J. Charles Kelley site (41BS908) in honor of a key figure in the Peabody-Sul Ross Expedition and a preeminent archaeological researcher of the Big Bend (Alex 1999). A series of buried occupations were uncovered at the site that included two Late Paleoindian stone-based hearths in the lower strata, one mostly eroded and the other intact. Charcoal from the former yielded a conventional corrected radiocarbon date of $8880 \pm 50$ RCYBP$^4$ (2-Sigma calibrated date of 8030–7730 cal. B.C.$^5$). The intact hearth had a diameter of ca. 1.2 meters (m) and was basin-shaped, having been constructed in a broad, shallow pit. Associated charcoal provided a date of $8890 \pm 90$ RCYBP (2-Sigma calibrated date of 8080–7700 cal. B.C.). A high percentage of Cheno-am$^6$ fossil pollen recovered from this strata led to a tentative hypothesis that warm, xeric conditions prevailed at this time (Alex 1999:15–16). Limited testing below this level revealed the presence of chipped stone debitage and fire-cracked rock (FCR); thus there is an even earlier cultural presence at the site. Unfortunately, time and construction constraints precluded further investigation. Yet, this discovery supported earlier predictions that sites of this age are buried and preserved in discrete, if not unique, settings within the region.

A recent SMU dissertation (Seebach 2011) provides a synthesis of Trans-Pecos sites and isolated projectiles attributable to Folsom and later Paleoindian groups and proposes hypotheses in regard to raw material economies, landscape use, and hunting behaviors to explain patterns in the data set. Seebach notes that local stone sources were used for over 80 percent of early Trans-Pecos projectile points, and that these and other Trans-Pecos stone sources are only sparingly represented among artifacts in adjacent regions to the north and east.

4. RCYBP is the acronym for “radiocarbon years before present.” It represents a conventional radiocarbon date that has not been calibrated or adjusted to the modern calendar or to years before present (January 1, 1950; see Footnote 2).

5. When either “cal B.C.” or “cal B.P.” occurs after a date it means that raw radiocarbon data has been calibrated or adjusted with the aid of dendrochronology (tree ring dating) to either the modern calendar (e.g., cal B.C./A.D.) or to “before present” (e.g., cal B.P.; see Footnote 2).

6. Archaeologists use the term Cheno-am for carbonized seeds and pollen of either Chenopodium or Amaranthus because extreme heat can destroy identifying portions making it impossible to confidently separate seeds/pollen of the two genera.
Armed with these data, and under the assumption that Paleoindians were wide-ranging hunter-gatherers, Seebach (2011:274–275) posits that mobile Late Paleoindian populations filtered “from the Trans-Pecos southward into Mexico” rather than in the opposite direction. He attempts to model Paleoindian use of the landscape through consideration of likely resources targeted during the Late Pleistocene/Early Holocene—plant, animal, and other resources (notably raw materials suitable for the manufacture of stone tools). In addition, he proposes seven subregions for the Trans-Pecos based on “gross measures of elevation,” two in what he considers uplands and the other five in lowlands (2011:83). Cross-cutting these subregions, Seebach (2011:269) observes that most Paleoindian sites and artifacts occur between 1,000–1,500 m above mean sea level (AMSL), a zone corresponding to “the ecotone between the lowlands and the mountains, as well as the elevated grasslands (Diablo Plateau, Marfa Highlands) in the region.” To explain the relatively low numbers of sites and isolated projectile points, he (2011:268, 277) offers several possibilities: 1) large campsites such as Chispa Creek served as “hubs” from which family units or hunting parties would travel in search of resources, with scattered projectile points representing this dispersion; and 2) the data “may signal only occasional forays into the region by hunters unable or unwilling to adapt to the desert conditions.”

The above summary provides an overview of the state of Paleoindian research in much of the eastern Trans-Pecos region prior to discovery and investigation of the GLD site. Despite Seebach’s recent contributions to Paleoindian research of the Trans-Pecos, a host of interpretive issues remain, such as how intensely the region was used, what landscapes were utilized, what constituted these people’s diet, and myriad technological questions in regard to stone tools, cooking features, and other behaviors. In addition, any consideration of Paleoindian behavior should be in tandem with an understanding of the paleoenvironment and there was little such associated information prior to discovery of the GLD site.

**The Genevieve Lykes Duncan Site**

The GLD site was discovered in April 2009 (Fig. 1). The initial find—an intact Early Archaic rock-lined hearth exposed in a recently carved arroyo wall—was made by ranch manager Homer Mills. During a subsequent trip to the site in July 2010 by Center for Big Bend Studies (CBBS) archaeologists, accompanied by geoarchaeologist Dr. Charles Frederick, another stone-based thermal feature was discovered downstream in the cutbank of the same arroyo. Like the Early
Archaic hearth, it appeared to be remarkably intact. Radiocarbon dating of three charcoal samples from this feature by two different laboratories yielded a Late Paleoindian date of ca. 11,000 cal. B.P. (ca. 9000 cal. B.C.). Finally, a buried and well-preserved early site had been found, and circumstances did not preclude further excavation, as was the case at the J. Charles Kelley site.

Aerial photography and a testing phase were initiated at the GLD site in December 2010, the latter consisting of both backhoe trenching and hand-excavated units. Through these investigations, as well as scrutiny of the surface, a total of 17 features were identified. A geoarchaeological investigation of the site was also begun at this time under the direction of Frederick, and his findings

Figure 1. Location of the Genevieve Lykes Duncan site (41BS2615) and Green Valley in the eastern Trans-Pecos region of Texas. Drafting by David Hart and Letitia Wetterauer.
led to the site being divided into three localities: Terlingua, Broadway, and Mask (Fig. 2). While research has been conducted in each of these localities, the focus

Figure 2. Aerial view of the Genevieve Lykes Duncan site (41BS2615) showing the site boundary, inter-site localities, and the initial Late Paleoindian feature (F-1) discovered at the site. Photogrammetry by Mark Willis in hillshade with 50-cm contour lines; drafting by Samuel Cason.
of this article is on the Broadway locality where Late Paleoindian deposits are exposed in the arroyo walls.

Of the 17 cultural features identified at the site during the testing phase, and based on either radiocarbon dating or stratigraphic positioning, a total of 9 are from the Late Paleoindian period. All are in the Broadway locality, sandwiched between upper and lower gravel beds that served to seal and protect the deposits over millennia. Two other features are also in this locality: an undated near-surface hearth and an Early Archaic hearth just above the upper gravel bed. The upstream Mask locality contains four hearths, two of which yielded Early Archaic (ca. 6500–2500 B.C.) radiocarbon dates; the other two hearths in this locality are surficial and undated. The remaining two cultural features are in close proximity within the downstream Terlingua locality. One of these, a rock-lined hearth, has been dated to the Middle Archaic period (ca. 2500–1000 B.C.) and the other, a stone-free hearth, likely has a similar age.

Findings from the 2010–2012 testing phase at the GLD site have provided an array of significant data concerning some of the earliest occupants of the Big Bend as well as the ancient and evolving environment in which they lived. Particularly noteworthy in these early deposits are the intactness of the cultural features, the abundance and preservation of charcoal, the presence of rock as heating elements in all features, and the occurrence of groundstone artifacts. Paleoenvironmental data from wood charcoal identifications, pollen and phytolith analyses, and an examination of gastropods have also been forthcoming, helping to rewrite our understanding of the early formation of the Chihuahuan Desert.

Site Setting and Environmental Parameters

Location
The GLD site is located in the heart of the Big Bend region of Texas in west-central Brewster County, ca. 4 kilometers (km) downstream from the headwater of Terlingua Creek.7 This segment of the creek turns sharply to the south and opens into an extensive alluvial basin known as “Green Valley.” The site lies

---

7. The headwater of Terlingua Creek has been referred to by some as the confluence of Hackberry and Paradise draws, ca. a mile east of the Presidio-Brewster county line. “TERLINGUA CREEK,” Handbook of Texas Online (http://www.tshaonline.org/handbook/online/articles/rbt29), Internet, accessed August 11, 2015. Published by the Texas State Historical Association.
within the northeastern portion of both the Chihuahuan Desert and the Chihuahuan biotic province, the latter defined by Dice (1943) and Blair (1950). It is in the easternmost extension of the Basin and Range physiographic province defined by Fenneman (1931).

Positioned on the interfluve that separates Terlingua Creek from Davenport Draw, the site has an approximate elevation of 1,122 m AMSL. Terlingua Creek is located ca. 120 m west of the GLD site, and Davenport Draw lies ca. 280 m to the southeast (Fig. 3). Late Paleoindian deposits at the GLD site are exposed in the walls of an arroyo that was cut approximately 12 years ago by overbank floodwaters from Davenport Draw. This arroyo cuts through the site in a northeast to southwest direction. Except to the south and southeast, the site is generally bounded by a broken and rugged topography of canyons, deeply incised arroyos, and volcanic hills (Barnes 1979). To the southeast lies the heart of Green Valley, a vast lowland made up of flats and outwash plains truncated by numerous arroyo systems and surrounded by rolling hills and mesas (Keller 2005:1). Importantly, the GLD site lies within an ecotone where the upper edge of the lowland desert meets the southernmost foothills of the Davis Mountains. Consequently, the site locality had good access to water, the most precious commodity in the region, and was logistically positioned for the convenient exploitation of a number of biological and geological resources.

**Geologic and Biotic Diversity in the Big Bend**

Many factors are responsible for the biodiversity and geodiversity in the Big Bend region, such as the wide range in elevations, climate, soils, and a complex geological history. A broad overview of the geology, flora, fauna, climate, and paleoenvironment is provided below, and a more localized review of geologic and biotic resources in the vicinity of the GLD site follows.

**Geology**

The Big Bend has been aptly described as “a confused and jumbled landscape . . . shaped by forces both gradual as well as cataclysmic” (Keller 2005:1). With origins in the Paleozoic Era some 570–245 million years ago (mya), marine sediments deposited in a deep oceanic setting were folded during the collision of tectonic plates.8 Notably absent in the region during the subsequent Mesozoic Era (245–66 mya) are deposits from the Triassic and Jurassic periods.

---

8. Geologic date ranges, periods, and epochs are taken from Henry (1998: Figure 3).
Figure 3. Location of the Genevieve Lykes Duncan site (41BS2615) on the interfluve separating Terlingua Creek and Davenport Draw. Shaded areas on the map denote areas with elevations of 4,000 feet AMSL and above. Drafting by Letitia Wetterauer.
Late Paleoindian Occupations at the Genevieve Lykes Duncan Site

(ca. 245–144 mya). During the entire length of the Cretaceous Period (ca. 144–66 mya), a layer-cake sequence of marine strata were deposited in tandem with receding ocean levels. Throughout the Paleocene and the beginning of the Eocene epochs (ca. 66–50 mya), a regressive sequence of sedimentary deposition took place, contemporaneous with tectonic uplifts. During the remainder of the Eocene and throughout the Oligocene Epoch (ca. 50–23.7 mya), there was a succession of three major volcanic eruptions which deposited a series of ash and lava flows associated with faulting and extensional tectonics through the first part of the Quaternary Period (1.6 mya–present) (Henry 1998; Urbanczyk et al. 2001). One major eruption from the Paisano caldera near Alpine, Texas, spread a massive ash flow sheet throughout the vicinity (MacLeod 2003), its southern terminus ca. 10 km to the west-northwest and north of the GLD site and historically referred to as the “Escondido Rim” (Keller 2005; Cloud 2013:155). During the subsequent portion of the Quaternary Period, erosional events shaped the landscape, producing alluvial features and talus slopes that, to this day, continue to form around massive and resistant volcanic features (Berry and Williams 2008).

The abundance and variety of toolstone in the greater Big Bend is directly linked to the complex geological history of the region. From sedimentary, igneous, and metamorphic origins, there are numerous sources of raw material suitable for the manufacture of stone tools. Unfortunately, these have been under-studied, with only a few handfuls of source areas documented to various degrees (Mallouf n.d.). Notable toolstone in the Big Bend includes Burro Mesa silicified tuff, Caballos novaculite, Maravillas chert, other cherts, siliceous hornfels, jasper, felsite, siliceous rhyolite, silicified wood, chalcedony, agate, siltstone, claystone, mudstone, quartzite, andesite, basalt, trachyte, skarn, dacite, compact limestone, and welded tuff (Mallouf 1985; Banks 1990; Cloud and Mallouf 1996; Chmidling 1998; Mallouf n.d.). Due to their complex origins, sometimes the color, texture, and quality or knappability of a particular stone may differ dramatically among nearby outcrops, even those adjacent to one another or within a single outcrop. Thus, identifying a discrete source used for a specific stone tool can be extremely challenging.

Another notable stone used prehistorically in the Big Bend is kaolinite, a distinctive metamorphosed clay with a waxy texture. Relatively soft and malleable, it was shaped into a variety of stone ornaments. It is notable that the vast majority of kaolinite ornaments found in the Big Bend are white or off-white, although other colored examples occur in the region and around the world.
While multiple sources are suspected in the region, only one has been thus far identified near the western edge of Burro Mesa in Big Bend National Park (Alex 1990; Mallouf n.d.).

**Flora and Fauna**

Following Dice (1943), Blair (1950:106–107) placed much of the Trans-Pecos region of Texas within the Chihuahuan biotic province, noting that its vegetation was highly varied due to topography and elevation and that it contained the richest assemblage of mammalian fauna of any province in the state. More recent work by Powell (1998:4–12) divided the complex and diverse flora of the Trans-Pecos into five basic vegetative types: 1) Chihuahuan Desert Scrub, 2) Grassland, 3) Oak-Juniper-Pinyon Woodland, 4) Conifer Forest, and 5) Riparian Communities. Each of these plant communities are confined to specific and different elevation zones, encompassing the lowest settings along the Rio Grande (ca. 1,800 feet AMSL) to the highest peaks of the regional mountains (Guadalupe Peak being the highest at 8,749 feet AMSL). In Big Bend National Park—one of the most researched areas in the region and with a striking example of the faunal diversity in the province—there are ca. 75 species of mammals, 56 species of reptiles, 11 species of amphibians, 450 species of birds, 40 species of fishes, and 3,600 species of insects (Wauer and Fleming 2002). Many, if not most, of the numerous species of plants and animals in the region were of some use to hunter-gatherers. In fact, during excavations at Bee Cave—ca. 43 km east-southeast of the GLD site—M.R. Harrington (1928:315) discovered “part of a necklace made of sections of the legs of some large iridescent green beetle neatly strung on a fine fiber cord” within the grave offerings of a burial. For complete lists of the plants and animals that reside in the Big Bend region and associated biomes, the interested reader is referred to Powell (1998, 2000), and Wauer and Fleming (2002).

**Climate**

The diverse climatic regime of the Big Bend is owed to a number of factors, including location, elevation, and topography. This arid to semi-arid region is characterized by hot summers, mild winters, and low average precipitation. June and July are the hottest months with temperatures often exceeding 100° Fahrenheit (F) in the lower settings; January is the coldest month, but extended temperate periods are common during the winter months. Precipitation in the Big Bend can either be widespread or localized, with about 70 percent of it
falling during the summer monsoon season (typically running from July through September), often during intense thunderstorms. A lesser amount of precipitation comes at this same time from the remnants of hurricanes and tropical storms emanating from the Pacific Ocean and the Gulf of Mexico. A weather station maintained from 1914–1928 at the 02 Ranch headquarters (ca. 3.9 km south-southeast of the GLD site) provides information on these parameters near the site during the early twentieth century. These data indicate the area had an average annual temperature of 63.5° F and a mean annual precipitation of 14.13 inches (in) (Keller 2005:9–12). More recent data from the region, collected from 1951–1980, indicate the GLD vicinity at that time had an average annual temperature of 63° F and an average annual precipitation of ca. 12.5 in (Larkin and Bomar 1983:18, 50). Importantly, both the temperature and rainfall data indicate widespread deviations per month and per year (Riggio et al. 1987).

**Paleoenvironment**

Based on macrobotanical remains recovered from woodrat middens in the Big Bend, woodland xerification began sometime before 22,000 years B.P. and was in full swing by 11,000 years B.P. (Wells 1976, 1985). While the montane woodlands remained confined to the highest elevations, the pinyon-juniper-oak association expanded its range downslope to the uppermost border of the lowlands ca. 20,000–15,000 years B.P. (Wells 1966). Additional woodrat midden studies show a steady increase in aridity on a south-to-north gradient throughout the subsequent Paleoindian period (Wells and Hunzicker 1976; Van Devender and Burgess 1985; Van Devender et al. 1987; Van Devender 1990), and these drying conditions favored a retreat of the woodlands and the spread of Chihuahuan Desert species throughout the region. Seebach (2011:52) has posited that this biotic transition was not so pronounced in the Big Bend compared to other regions, and that the vegetative communities during the Late Pleistocene-Holocene interface may have looked very similar to what we see today. Pollen analyses show a similar trend, although these data indicate the vegetation shifts were somewhat earlier, with a mosaic of woodlands, pinyon-dominated parklands, and scrub grasslands in the region until ca. 14,000 years B.P. (Bryant and Holloway 1985:50).

Various threads of evidence from select Late Pleistocene fauna, such as horses (*Equus* sp.), camels (*Camelops* sp.), and sloths (family Northrotheridae), indicate that these animals were generally browsers of xeric grasslands and desert scrub species (Harris 2003; Vetter et al. 2008; Seebach 2011). Thus, their
presence in the Trans-Pecos and peripheral areas prior to the mass Pleistocene extinction confirms the floral data above, indicating gradual drying of the region at this time. Due to a lack of Paleoindian kill sites in the region, particularly of known prey species, Seebach (2011:62–63) suggests “... large megafaunal species were only transitory visitors in the area during the Paleoindian period.” He offers a similar argument concerning bison, both before and after the Pleistocene extinction, concluding that “... it is perhaps best to consider bison to have been an occasional or rare species in the area, rather than a full-time resident.”

Lastly, it is noteworthy to mention that some insects (particularly beetles) are sensitive to environmental change and can be excellent tools in understanding past environments (Buckland 2000). The results of fossil insect studies, in general, support the macrobotanical, pollen, and paleontological data summarized above (Elias 1987; Elias and Van Devender 1990).

**The GLD Site Ecotone**

A recent study of Late Paleoindian occupations in the greater Trans-Pecos divided the region into seven subregions based on gross elevation ranges, and each of these is characterized by unique biotic communities (Seebach 2011). One of the subregions, Green Valley, contains the GLD site as well as a fair number of Paleoindian projectile points, and Seebach (2011:87–88) has suggested game animals were the resources most likely targeted here; however, Green Valley, as broadly defined by Seebach and others, also contains a rich assemblage of flora that undoubtedly played a role in the presence of Late Paleoindian groups. In fact, numerous ecotonal settings occur in the heart of Green Valley and along its peripheries, providing abundant biodiversity in respect to both plants and animals. The valley proper is a low desert scrubland setting, whereas marginal areas within the broader valley—topographically termed foothills—are distinguished by desert grassland communities. Consequently, the GLD site was ideally situated amongst a range of environments—1) the desert scrubland vegetative community of the immediate site area, 2) the elevated grasslands of the surrounding uplands, and 3) the adjacent riparian zone of Terlingua Creek—each with different floral and faunal resources that could be exploited by the Late Paleoindian occupants. Another critical resource—material suitable for the manufacture of stone tools—outcrops in the adjacent foothills and is available in the stream load deposits of Terlingua Creek and Davenport Draw. More detailed information on these resources is provided below.
Terlingua Creek
Terlingua Creek is one of only a handful of major tributaries of the Rio Grande in the Big Bend region. The creek supports extensive, but not continuous, riparian woodlands and aquatic life and offers refuge for a host of birds, mammals, amphibians and reptiles (Handbook of Texas Online 2010). During Late Pleistocene times, Terlingua Creek and Davenport Draw most likely flowed as perennial streams; today they are mostly intermittent, although ca. 900 m south of the GLD site Terlingua Creek flows as a perennial stream for ca. 2 km. Even as late as 1885, James B. Gillett, former Texas Ranger and later foreman of the G4 Ranch, described Terlingua Creek as “a bold running stream, studded with cottonwood timber as [and] was alive with beaver” (Gillett 1933:82). Moreover, Terlingua Creek and Davenport Draw serve both as critical water resources and major travel corridors for wildlife. Today, trees and plants along the creeks include honey mesquite (*Prosopis glandulosa*), Goodding’s willow (*Salix gooddingii*), Arizona cottonwood (*Populus fremontii*), spiny hackberry (*Celtis pallida*), arrowweed (*Pluchea sericea*), littleleaf sumac (*Rhus microphylla*), guayule (*Parthenium argentatum*), common cocklebur (*Xanthium strumarium*), common sunflower (*Helianthus annuus*), sand dropseed (*Sporobolus cryptandrus*), and bentgrass (*Agrostis* sp.). A number of aquatic vertebrates and invertebrates are indigenous to Terlingua Creek as well (Handbook of Texas Online 2010). In particular, the Bailey Rio Grande beaver (*Castor canadensis mexicanus*) apparently once occupied at least portions of Terlingua Creek, so much so that in 1747 a segment far downstream was named “the arroyo and cottonwood grove of the beaver” by the Spanish explorer Rábago y Therán (Madrid n.d.:188).

The Desert Scrubland-Grassland Ecotone
The ecotone located between the Terlingua Creek and Davenport Draw floodplains and the surrounding uplands is an example of where the Chihuahuan Desert scrubland meets the desert grassland community. In the immediate vicinity around the site this ecotone exists between ca. 1,177 m and 1,225 m AMSL, but in a broader sense it occurs in the Trans-Pecos region between ca. 1,067 m and 1,219 m AMSL. According to Powell (1994:15), “In Trans-Pecos Texas the contact of desert grassland and Chihuahuan desertscrub is complex, being rather smooth at some sites along mountain slopes, and at many other localities in broken topography existing as a mosaic of vegetation types appearing in irregular habitats that support them.” Xeric shrubs and succulents dominate the desert scrubland-grassland ecotone at the GLD site, with a lesser number of
species of grass and forbes as part of the understory and in small open areas. The many species from this diverse floral assemblage were no doubt used by prehistoric hunter-gatherers for construction, fibers, dyes, food, and medicine. The floral assemblage in the desert lowland is dominated by honey mesquite (*Prosopis glandulosa*) and creosotebush (*Larrea tridentata*), with tarbush (*Flourensia cernua*), four-wing saltbush (*Atriplex canescens*), Morman tea (*Ephedra trifurca*), lotebush (*Ziziphus obtusifolia*), allthorn (*Koeberlinia spinosa*), tasajillo (*Cylindropuntia leptocaulis*), cane cholla (*Cylindropuntia imbricata*), Texas rainbow cactus (*Echinocereus dasyacanthus*), hedgehog cactus (*Echinocereus sp.*), clumped dog cholla (*Opuntia aggeria*), prickly pear cactus (*Opuntia sp.*), various grama (*Bouteloua sp.*), bush muhly (*Muhlenbergia porteri*), three-awns (*Aristida spp.*), fluffgrass (*Dasyochloa pulchella*), and minor quantities of black grama grass (*Bouteloua eriopoda*) and water bentgrass (*Agrostis semiverticillata*). Plants in the upper part of the ecotone are dominated by creosotebush and four-wing saltbush, with Chino grama grass (*Bouteloua ramosa*) becoming more common with elevation. Other plants on these slopes include tasajillo, cane cholla, clumped dog cholla, pitaya cactus (*Echinocereus stramineus*), prickly pear cactus, ocotillo (*Fouquieria splendens*), viscid acacia (*Acacia neovernicosa*), and a small number of lechuguilla (*Agave lechuguilla*), Spanish dagger (*Yucca torreyi*), and button cactus (*Epithelantha sp.*).

There is also a great diversity of faunal species within this ecotone that could have been exploited by prehistoric hunter-gatherers, including reptiles (class Reptilia), squirrels (family Sciuridae), gophers (family Geomyidae), mice (families Heteromyidae and Muridae), rats (family Cricetidae), cottontail rabbits (*Sylvilagus* sp.), black-tailed jackrabbits (*Lepus californicus*), porcupines (*Eritherizon dorsatum*), raccoons (*Procyon lotor*), ringtail (*Bassariscus astutus*), striped skunks (*Spilogale gracilis*), bobcats (*Lynx rufus*), badgers (*Taxidea taxus*), foxes and coyotes (family Canidae), peccaries (*Tayassu sp.*), deer (*Odocoileus sp.*), and antelope (*Antilocapra americana*). Very few animal species in the Trans-Pecos, especially mammals of medium to large body size, are restricted to any vegetative community and can move about the region as necessary (Schmidly 1977). Evidence of most of the above species has been recovered from archaeological sites in the eastern Trans-Pecos/Big Bend region (Coffin 1932; Turpin 1998; Cloud and Piehl 2008:193).

The floral assemblage in the upper elevations of this ecotone (ca. 1,189–1,219 m AMSL), are atypical of grasslands best developed at 1,067–1,585 m AMSL (Powell 1998:7). Significant soil development is virtually absent within the
adjacent uplands, which contain a patchwork of thin soil and fragmented igneous detritus that supports a thinly distributed mixture of shrubs, succulents, grasses, and forbs. While paleovegetation data from the immediate area is lacking, evidence from packrat middens to the east and west suggest xeric woodland communities were being replaced by desertscrub communities in the Chihuahuan Desert during the early Holocene immediately after the end of the Late Wisconsin glacial period (Van Devender et al. 1987:332). Most likely this transition was gradual, with woodland, desertscrub, and grassland communities providing a mixture of available vegetation in the GLD site area during Late Paleoindian occupations. Nuts and acorns from woodland species such as oak (*Quercus* sp.), walnut (*Juglans* sp.), juniper (*Juniperus* sp.), and pinyon (*Pinus* sp.) would have served as food and medicine (Abbot et al. 1996: Table 4). Also, the plant communities of the elevated grasslands provided an important grazing habitat for large mammals such as mule deer (*Odocoileus hemionus*) and antelope. Although there is no definitive evidence of prehistoric groups exploiting desert bighorn sheep (*Ovis canadensis nelsoni*) in the Big Bend, they have historically inhabited the desert mountain ranges of western Texas (Davis 1974; Schmidly 1977) and have been found in Late Pleistocene contexts in Culberson County, Texas (Ayer 1936:613–615). If present in the region during Late Paleoindian times, they may have ventured into the uplands near the GLD site.

**Raw Material Availability**

The GLD site rests on a low terrace of young Quaternary alluvium that transitions upslope to the Pruett Formation, one of several volcanic formations of the Buck Hill series that is composed mostly of andesite. Further upslope, the Pruett Formation is overlain by the Cottonwood Springs Basalt which is up to ca. 100 m thick in places (Barnes 1979).

The depositional setting at the GLD site is characterized by three episodes of floodplain stability with intermittent periods of sheetwash. During these times, soil formation processes took place, interrupted by two turbulent flood events that are represented by moderately thick gravel layers. The differences in lithology and angularity of gravels from each of these layers indicate separate flooding events emanating from Davenport Draw during the early portion of the Late Paleoindian period, and followed by Terlingua Creek during the Early Archaic period (Frederick et al. 2011; Gregory and Frederick 2011).

Toolstone is plentiful near the GLD site and includes various members of the mudrock family, jasper, chalcedony, moss agate, chert, quartzite, and siliceous
rhyolite—all available in the secondary stream load deposits of Terlingua Creek and Davenport Draw. The most abundant material is a red-hued mudrock available in both the stream load deposits of Terlingua Creek and along the lower beds of nearby hillsides. There is a complex range of lithologies, varied grain size, and visual patterns (e.g., homogeneous, speckled, banded, etc.) within this mudrock family that consist of siltstone, mudstone, and claystone (Potter et al. 2005). Stone debitage and tools made of mudrock from the GLD site appear to contain pyroclastic grains and could be termed “tuffaceous” (Fisher 1966); therefore, for the purpose of this report, these rocks are classified as “indurated tuffaceous mudrock” (Corkill 1999). These mudrock beds may have become further indurated through low-grade metamorphic processes where the stone recrystallizes after burial (Hughes et al. 2011). Quartz-seamed jasper, white-colored chalcedony, and red-colored agate are available in the nearby Cottonwood Spring Basalt outcrops of the uplands. In addition, a distinctive yellowish-brown quartzite can be collected from Quaternary gravels on the outwash plains of Green Valley, and siliceous wood of knappable quality is available from Cretaceous outcrops in the area (Barnes 1979).

**Methodology**

Initial investigations at the GLD site consisted of recording the site (including aerial photography), backhoe trenching, and profiling. The investigation then focused on the Broadway locality where Late Paleoindian deposits were exposed. Arroyo walls in that portion of the site were inspected and troweled and deep excavations were initiated in conjoining test units (Units 1 and 2) placed above the ca. 11,000 cal. B.P. thermal feature.

**Site Recording**

A pedestrian survey was conducted in the vicinity surrounding the modern and unnamed arroyo containing the exposed Late Paleoindian and Archaic features and a site boundary was established. Global positioning system (GPS) units were used to record the provenience of surface artifacts and features, and a CBBS site form was completed. A state trinomial number was secured from the Texas Archeological Research Laboratory and this designation is 41BS2615. The site was mapped using low altitude aerial photography prior to any groundbreaking efforts. Photogrammetry software in tandem with high-resolution aerial photographs allowed creation of a high resolution, three-dimensional model of the surface of the site.
**Backhoe Trenches and Profiling**

A series of backhoe trenches (BHT) were excavated to discover additional features and artifacts and to determine the area of the site having the best research potential. Ten such trenches were excavated at the Broadway locality; eight were placed perpendicular to and adjoining the arroyo walls (BHT-6, BHT-8, BHT-9, BHT-10, BHT-11, BHT-12, BHT-13, and BHT-14), while the other two (BHT-3 and BHT-4) were situated within the floor of the arroyo, parallel to its long axis (Fig. 4). Of the former, BHT-6, BHT-9, BHT-10, BHT-11, and BHT-12 are on the southeast side of the arroyo; BHT-8, BHT-13, and BHT-14 are on the northwest side. These trenches are of varying length and ca. 65 centimeters (cm) wide, although some of the deeper ones are somewhat wider, having been stepped for safety.

Select portions of both the backhoe trenches and arroyo walls were troweled or scraped with dental tools to expose additional charcoal, features, and artifacts and, where appropriate, profiles were drawn. Given the very high clay content in the deposits, the dental tools proved to be especially effective in exposing features and soil strata in the walls. Profiles were also completed for all features exposed in the arroyo and BHT walls, and a total data station (TDS) was used to record the proveniences of all cultural manifestations discovered.

**Arroyo Exploration Areas**

Five discrete areas along the arroyo walls in the Broadway locality were explored intensively, and these were designated Exploration Area A through E (see Fig. 4). In three of these—areas A, B, and D—arroyo walls were extensively troweled to expose charcoal, burned rocks, or other cultural residue. In Exploration Area B this effort exposed the remnants of a thermal feature designated as Feature 14 (F-14). The other two exploration areas (C and E) were within low benches along the floor of the arroyo. These benches were within the targeted Late Paleoindian deposits and excavated as single units. All cultural materials discovered in these areas were plotted on scaled plan view maps showing the bench configurations. Elevations were recorded using pins set with the TDS and line levels.

**Test Excavations—Units 1 and 2**

Prior to the excavation of Units 1 and 2, a grid system in meters was established for the site. In order to roughly parallel the arroyo in this portion of the site, especially in the area of F-1 where Units 1 and 2 were positioned, a northeast-
southwest orientation, rather than north-south, was used for the grid. Units 1 and 2 were placed side by side along the edge of the arroyo, directly overlaying F-1, which was exposed in the arroyo wall. Grid-north in these units is in a

Figure 4. Aerial map of the Broadway locality showing the recent arroyo, backhoe trenches (BHT-_), exploration areas (EXP-_), and features (F-__). Photogrammetry by Mark Willis in hillshade with 50-cm contour lines; drafting by Samuel Cason.
general northeast direction. A primary datum (LD1) with an arbitrary top elevation of 100.00 m was strategically positioned about 15 m southeast of the arroyo to provide a panoramic view across the site, while 4 other datums were established for back-shots and future reference points.

Units 1 and 2 were excavated with shovels, trowels, and pick mattocks in 10-cm, arbitrary levels until a gravel bed was encountered; picks and shovels were used to remove those gravels. Once the targeted zone with cultural materials was reached below the gravel, 5-cm levels were employed. Prior to reaching the top of F-1, a profile was drawn of the feature and arroyo wall (looking grid-east).

**Bisectional Excavation of Feature 1**

Units 1 and 2 were positioned to perfectly bisect F-1. A 10-cm-wide baulk was used along this intersection to provide profile views on the grid-north and -south sides of the feature. In addition, a “collar-like” baulk was left around the perimeter of the feature to protect and stabilize it for future reference as well as on-site tours. Dimensions, morphologies, proveniences, and other attributes were recorded on feature excavation forms. A detailed plan view of F-1 was drawn to accompany the form. The provenience of each feature element (i.e., piece of FCR, charcoal, etc.) was recorded using the TDS and entered into a data/provenience log. Additional mapping was achieved with a digital camera mounted on a monopod. The camera was held directly over and perpendicular to the feature to provide an accurate plan view image. In the office this image was digitized and ultimately used to create an accurate, computer-generated drawing of the feature.

**General Excavation Procedures**

Fill from the excavations was water-screened through 0.16-cm hardware mesh (standard window screen). The locations and elevations of all artifacts, faunal remains, and other cultural residue found *in-situ* were documented. Field specimen numbers were assigned for each level to both materials recovered from the screen and for items found *in-situ*. Excavation level forms were completed for each excavated level and digital photographs were selectively taken of features, artifacts, stratigraphic contexts, and field activities.

**Sampling Procedures**

Outside consultants were contracted for various analyses. The sample collection methodologies for charcoal, macrobotanical materials, pollen, phytoliths, starch grains, and residue analyses followed Cummings (2007). Charcoal was
collected from both within and outside feature boundaries and select samples were submitted for radiocarbon assay to PaleoResearch Institute (PRI), Boulder, Colorado; Beta Analytic, Miami, Florida; and International Chemical Analysis (ICA), Miami, Florida. Wood charcoal identifications were provided by PRI for the samples they dated; they also analyzed select samples for macrobotanical remains, pollen, starch grains/phytoliths, and protein residue. The Palynology Research Laboratory at Texas A&M University, College Station, analyzed select FCR and associated soil from F-1 for starch grains and phytoliths (see feature descriptions). Gastropod shells collected from two strata between the upper and lower gravel beds were identified by Terra Nostra Earth Sciences Research in Tucson, Arizona. Furthermore, to facilitate future pollen and phytolith analyses, stratigraphic columns of sediment just outside and on either side of F-1 were collected in 2-cm increments.

**Laboratory Procedures**

Once in the laboratory the unmodified debitage was washed with tap water and a soft toothbrush and dried on fine-screen racks. Select chipped stone tools were not washed to preserve the possibility of future residue analysis. Lot numbers were then assigned to artifacts and samples. Artifacts were labeled with state trinomial numbers and lot numbers, coated with polyvinyl acetate varnish and placed in zippered polyethylene bags with the appropriate artifact/sample tags.

Unmodified debitage and the few chipped stone tools recovered were examined and documented during the lithic analysis. Following Goode (2002) and Andrefsky (1998), various traits such as method of manufacture, size, thermal alteration, and stage of reduction were characterized for the unmodified debitage. Raw material types were identified and further categorized by texture, translucency, structure, and color. The presence or absence of patina was informally noted during the course of analysis. In addition, color was characterized using either a Munsell® Soil Color Chart or Rock Color Chart (Geological Society of America 1991), but described only with generalized color values, value ranges, and corresponding names.

**Geoarchaeological Investigation**

**Large-Scale Stratigraphy–Historical Antecedents**

Although Homer Mills’ discovery of a buried hearth in the Mask locality was accidental, the eventual identification of the site was the end result of a focused
strategy employed by CBBS archaeologists to seek out and identify Paleoindian-age alluvial deposits, and then search them for potential occupational residues. As previously noted, this geoarchaeologically based strategy was built on the pioneering interdisciplinary fieldwork during the 1930s of geologists Claude Albritton and Kirk Bryan (1939) and archaeologists J. Charles Kelley, T.N. Campbell, and D.J. Lehmer (Kelley et al. 1940) in the region south of Alpine, Texas. Their work linked the sequence of the stream deposits (also known as the alluvial stratigraphy) with the age of the archaeological sites within them, and led to the recognition of three distinctly different aged alluvial deposits or formations named, in order from oldest to youngest, Neville, Calamity, and Kokernot (Fig. 5). Albritton and Bryan (1939) described the appearance (e.g.,

Figure 5. Upper Panel: Drawing based on Albritton and Bryan (1939, Fig. 8) showing the stratigraphic relationships between the three formations they identified. Lower Panel: Photograph of a cutbank of Calamity Creek at the Elephant Mountain Wildlife Management Area illustrating the types of stratigraphic relationships shown in the upper panel. Photo by Charles D. Frederick.
color, lithology, thickness, fossil inclusions, and elements of soil development such as the presence and size of caliche nodules) and relative stratigraphic position of each alluvial deposit (see Fig. 5), whereas the artifacts recovered from each deposit were described in detail by Kelley et al. (1940). Together these data provide a field guide by which one may identify where sites of different ages may lie buried within the alluvial deposits of this region. Because their work occurred long before the advent of radiocarbon dating, the ages of each alluvial unit were estimated by the artifacts and fossils found within them.

The oldest deposit, the Neville Formation, contained fossil megafauna (specifically elephant and horse bones), and consisted of reddish-brown massive calcareous silts and conglomerate. This unit contained significant amounts of secondary calcium carbonate in the form of nodules ranging in size from 1.3 to >2.5 cm, vertically oriented cylinders up to 15.2 cm long, abundant diffuse calcium carbonate, and occasional indurated beds (Albritton and Bryan 1939:1430–1431). Given its fossil content, the Neville Formation was considered to have been deposited during the Pleistocene, more than 10,000 years ago.

The Calamity Formation, inset into the Neville Formation and overlain by the Kokernot Formation, consisted of brown to reddish-brown calcareous deposits of alluvial gravel, sand, silt, and clay. The upper part of the deposit exhibited a well-developed soil A horizon and it may contain buried soils in some locations. Albritton and Bryan (1939:1427) noted that the most characteristic attribute of the Calamity Formation was “the dark humic beds of clay and silt, which commonly contain hearths,” and they reported that its thickness ranged from 3.4 to 9.1 m. Estimates on the period of deposition of the Calamity Formation range from as little as 2,100 years (ca. 5300–3200 years B.P. [Marmaduke 1978:18]) to as much as 7,000 years (ca. 6500 B.C.–A.D. 700 [Mandel 2002:6; Cason and Cloud 2010:8]). A single radiocarbon age has been reported from near Albritton and Bryan’s (1939) type site for the formation along Calamity Creek (Mandel 2002:8–10). Here, a bulk soil sample collected from the calcic horizon of a buried soil at a depth of approximately 2.7 m below the surface (in the approximate middle of the formation) yielded an age of 6360±70 years RCYBP (TX-9018). With this date in hand, Mandel suggested deposition of the Calamity Formation was ongoing in the early Holocene, but was occasionally interrupted by periods of landscape stability and soil formation, one of which occurred around 6400 years B.P.

The youngest and most frequently exposed deposit identified by Albritton and Bryan (1939:1427) is the Kokernot Formation, described as “incoherent
beds which are mostly silt, sand, and gravel.” This deposit ranges in color from gray to brownish-gray to light gray to blondine and lacks secondary calcium carbonate. As described, the Kokernot Formation ranges in thickness from 30.5 cm (presumably as a thin veneer on top of the Calamity and Neville formations) to as much as 4 m, where it is presumed to be an alluvial fill inset into one or both of the older deposits. Cultural material occurs throughout the Kokernot Formation, which is thought to represent alluvial sedimentation from A.D. 1200 to 1890 (Albritton and Bryan 1939; Mandel 2002:6).

**Discovery of the Site and its Large-Scale Context**

Using the framework established by Albritton and Bryan (1939), the CBBS specifically sought out deposits that were of the right appearance and degree of soil development to contain Paleoindian occupations. Specifically, they sought alluvial deposits that were slightly redder than freshly deposited alluvium and that exhibited a calcic soil horizon characterized by small calcium carbonate nodules (also known as a Stage II or nodular calcic horizon). Deposits of this nature were routinely encountered by CBBS archaeologists. Periodically, after several localities had been identified, they were revisited by CBBS archaeologists in company with geoarchaeologist Dr. Charles Frederick. In many cases, as at GLD, the search for Paleoindian-age deposits has been facilitated by the dating of charcoal from selected features. These range finder dates proved critical in both finding the GLD site and understanding the large-scale geology in its immediate vicinity.

The nearly 7,000-year-old hearth that Homer Mills found at the Mask locality was about 1.3 m below the ground surface in the modern arroyo. The presence of a hearth of this age but at a relatively shallow depth suggested that the base of this alluvial deposit (presumed to be at least 4 m deep) could be old enough to contain Paleoindian-age occupations. Hence, we immediately began searching the arroyo walls downstream of the Mask locality but at greater depths, hoping to get lucky—which we did at the Broadway locality.

Once the initial excavations began, a third locality downstream of Broadway was recognized and designated the Terlingua locality. Examination of all three localities suggested that there was a broad pattern to the deposits, and subsequent cleaning of the arroyo walls in conjunction with the radiocarbon ages led to the recognition of three different aged unconformity-bounded alluvial deposits, also known as allostratigraphic units. Although tempted to directly link these large depositional units with Albritton and Bryan’s work, they are currently recognized as Allostratigraphic Units 1, 2, and 3, in order from oldest to youngest (Fig. 6).
Figure 6. Schematic drawing of the stratigraphic relationships observed within the arroyo at the Genevieve Lykes Duncan site. All radiocarbon data provided are conventional dates (RCYBP) not calibrated or adjusted to the modern calendar. Drafting by Charles D. Frederick.
Allostratigraphic Unit 1

Unit 1 is an alluvial deposit that began to form sometime before 10,730 years B.P. and continued until sometime between 6160 and 5025 years B.P., after which a period of erosion and channel entrenchment occurred. Prehistoric occupations within the unit range in age from the Late Paleoindian to Early Archaic periods. The most complete exposure of Unit 1, estimated to be about 6 m thick, is in the northeastern half of the arroyo within the Mask locality. The unit is partially preserved at the Broadway locality and completely absent in the Terlingua locality. The core of this deposit is reddish-brown (Munsell brown—7.5YR 4/3, moist; 7.5YR 5/4, dry), and the soils formed within it exhibit B horizons with ca. 2 to 7 percent of small (2–15 millimeter [mm] maximum diameter), irregular-shaped nodules of calcium carbonate and a few to common gypsum threads (2 to 12 percent by weight).

At the Broadway locality and clearly visible in BHT-6, Unit 1 has been subdivided into several distinct strata which bracket the prehistoric occupations, specifically the lower gravel bed, the paleosol, the post-paleosol, and the upper gravel bed (Fig. 7). Beneath the Paleoindian occupations lies the lower gravel bed, an extremely gravelly silt loam that in terms of composition appears to most closely resemble sediment in modern-day Davenport Draw. These gravels are overlain by the paleosol—a half-meter-thick stratum of buried, cumulic fossil soil—and encapsulates Paleoindian and Early Archaic occupations. This former soil is a dark brown (7.5YR 3/3, moist; 7.5YR 5/3, dry) clay to clay loam. The paleosol pinches out about 20 m to the northeast (toward the eastern valley margin and the Mask locality; before BHT-3). Immediately overlying the paleosol and beneath the upper gravel bed is a fine-grained, occasionally thin-bedded overbank alluvium comprised of a brown (7.5YR 4/4, moist; 7.5YR 6/3, dry) clay loam (the post-paleosol). The upper gravel, a slightly gravelly loam, is of highly variable thickness and exhibits a lithology most similar to the gravels in the modern channel of Terlingua Creek. Where Unit 1 is not significantly eroded, as at the Mask locality, a thin (20-cm-thick) A horizon caps the unit and is draped by a thin (25-cm-thick) veneer of Unit 3.

Allostratigraphic Unit 2

The next phase of alluvial sedimentation at the site occurred between approximately 5025 years B.P. to sometime shortly after 3285 years B.P., and contains very discrete, well-preserved Middle to Late Archaic occupation surfaces. Between 0.5 and 1 m of Unit 2 rests unconformably upon Unit 1 at the Broadway
locality, and it appears that ca. 1–2 m of Unit 1 had been removed by erosion prior to the deposition of Unit 2. This interface is very undulatory and at the Broadway locality has almost a meter of relief (see southeast end of BHT-6 profile in Fig. 7).

The most complete exposure of Unit 2 was revealed in the Terlingua locality where it is more than 4.4 m thick and contains three distinct parts: 1) a basal channel deposit consisting of interbedded loamy sand and gravelly sand, 2) a core of thin bedded and often laminated fine-grained overbank sediment, and 3) a weakly developed soil A horizon which formed in the top of the deposit. At the Broadway locality, only the latter two parts are present. The overbank sediments that comprise the core of the deposit are generally brown (7.5YR 5/4, moist; 7.5YR 6/3, dry) to dark grayish-brown (10YR 4/2, moist; 10YR 5/2.5, dry) clay loam and/or silty clay loam. Traces of sub-horizontal bedding are most prominent at the base of the unit where thin beds or laminae of fine sand accent the bedding. Small threads of gypsum comprising 5 percent to 11 percent by weight are common within the core of Unit 2, as well as within the A horizon that caps Unit 2. The latter is generally between 20 and 40 cm thick, exhibits no evidence of bedding, and is a dark brown (7.5YR 3/2, moist; 10YR 5/2, dry) to very dark grayish-brown (10YR 3/2, moist; 10YR 5/2, dry) clay or silty clay with moderately well-expressed structure (prismatic to sub-angular blocky). At a large scale, Unit 2 pinches out to the northeast of BHT-3 (it is only 20 cm thick in BHT-3) and thickens greatly (to more than 4 m) about 30 m southwest of BHT-6 in the direction of Terlingua Creek (see Fig. 5).

**Allostratigraphic Unit 3**

The uppermost depositional unit in the stratigraphic succession exposed at the GLD site, Unit 3, is comprised of brown (7.5YR 4/3, moist; 10YR 5/3 to 4/3, dry) thin-bedded and laminated overbank alluvium that exhibits little to no evidence of soil development. The texture of this deposit is variable, ranging from sandy loam to clay loam, but the core color appears to be fairly uniform. The interface between Unit 2 and Unit 3 is abrupt in some exposures, and gradational in others. None of the examined exposures of this deposit contained lenses of gravel but it is likely that isolated gravel lenses/beds may exist within it where the unit is thicker and inset into Unit 2.

Unit 3 is exposed on the modern ground surface and is typically thickest under plants and thinnest between them where overland flow during rain events erodes this deposit. At the Broadway locality, the thickness of Unit 3 increases
Figure 7. Schematic drawing of the grid-south wall of BHT-6 showing the stratigraphic features common at the Broadway locality (the upper gravel bed, the paleosol, and the lower gravel bed) as well as the dramatic and undulate nature of the erosional unconformity separating Units 1 and 2. Drafting by Charles D. Frederick.
away from the arroyo, which is best seen in the BHT-6 profile (see Fig. 7), where it is less than 10 cm thick at the arroyo and about 50 cm thick about 10 m to the south. This reflects erosional beveling of the ground surface adjacent to the arroyo along its length. On a much larger scale, Unit 3 pinches and thins to the northeast where it drapes the terrace surface as a thin wedge-like veneer, and becomes much thicker to the southwest of the Broadway locality near the modern channel of Terlingua Creek (see Fig. 5). No radiocarbon ages are available from Unit 3, but the lack of pedogenic development, prominent bedding, and presence at the top of this deposit suggest it is very young, certainly deposited within the last millennium, and possibly in the last few hundred years.

**Paleoenvironmental Reconstruction**

In addition to understanding the large-scale stratigraphic context of the site, geoarchaeological work has sought to elucidate details of the local environment at the time of the occupation. In particular, this work has focused on which stream was the dominant sediment source at the time, as well as conditions associated with formation of the paleosol.

As mentioned earlier, the site is situated near the confluence of two major streams—Terlingua Creek and Davenport Draw. Although it is tempting to say that this juncture today is where it has always been, it is clear that the actual confluence between these two streams has varied through time as their channels have slowly migrated. The course of Terlingua Creek appears to have been relatively constrained compared to that of Davenport Draw, which emerges from a bedrock-confined pass before joining Terlingua Creek. In the past, this confluence occurred at various points covering almost a mile of the Terlingua Creek valley, where it appears to have shifted laterally more like an alluvial fan. The Paleoindian occupation at the Broadway locality is within what would most likely be considered the Terlingua Creek valley. However, close examination of the lithology of the gravelly deposits of the two streams and of the gravel beds that bracket the Paleoindian age deposits suggests that the early deposits at the site were created by Davenport Draw and the later ones by Terlingua Creek, a hypothesis currently being tested by Brittney Gregory (personal communication 2016).

The paleosol within which the Paleoindian occupation is found appears to have been a very slowly developed cumulic soil that developed during a period of slower sedimentation on the floodplain. In the millennium preceding its development, sediment was being deposited at a rate of about 9 cm per century whereas during the period the paleosol was forming, sedimentation was much
slower, about 1.4 cm per century. Above the paleosol the sedimentation rate increased to about 5 cm per century. This diminished sedimentation rate may be due to movement of the Davenport Draw channel away from this location, or associated with a period of wetter climate that resulted in more effective vegetation cover and finer sediment load as well as a less flashy discharge.

Although few other paleoenvironmental details are currently available, some insight into the vegetation growing on the paleosol during the Late Paleoindian and Early Archaic period may be gleaned from examination of the stable carbon isotopic composition of the soil organic matter within the paleosol. The ratio of $^{13}\text{C}/^{12}\text{C}$ (also notated as $\delta^{13}\text{C}$, which is measured in parts per million or per mil with respect to a standard known as the Pee Dee Belemnite or PDB) of soil organic matter, can be used to discriminate broad groups of plants that contributed organic material to the soil when it was forming. This is a result of the chemical mechanisms by which plants photosynthesize that discriminate by different degrees against $^{13}\text{C}$ in carbon dioxide. As a result, cool-season plants and trees tend to favor the Calvin or $\text{C}_3$ photosynthetic pathway and yield $\delta^{13}\text{C}$ values between -32 per mil PDB and -20 per mil PDB, with a mean value of -27 per mil PDB. Warm-season perennial grasses and herbaceous plants typically use the Hatch-Slack or $\text{C}_4$ photosynthetic pathway and have stable carbon isotopic values between -17 per mil PDB and -9 per mil PDB, and with a mean value of -13 per mil PDB (Table 1).

By examining $\delta^{13}\text{C}$ values of soil organic matter in the paleosol, we can infer what relative proportions of $\text{C}_3$ and $\text{C}_4$ plants contributed organic matter to the soil by using a simple mixing model (cf. Nordt et al. 1994; Boutton 1996; Boutton et al. 1998). From this it becomes clear that the vegetation that contributed organic matter to the paleosol appears to have shifted significantly during the period of its formation. At the bottom of the soil the organic matter was largely derived from $\text{C}_3$ plants (ca. 70 percent), whereas in the middle of the soil, during the Paleoindian occupation, the $\text{C}_3$ contribution diminished to 41 percent in favor of

<table>
<thead>
<tr>
<th>Depth (cm)</th>
<th>$\delta^{13}\text{C}$ per mil PDB</th>
<th>Percent C$_3$</th>
</tr>
</thead>
<tbody>
<tr>
<td>182.5</td>
<td>-21.86</td>
<td>63.3</td>
</tr>
<tr>
<td>187.5</td>
<td>-21.93</td>
<td>63.8</td>
</tr>
<tr>
<td>195</td>
<td>-20.60</td>
<td>54.3</td>
</tr>
<tr>
<td>205</td>
<td>-20.02</td>
<td>50.1</td>
</tr>
<tr>
<td>215</td>
<td>-18.91</td>
<td>42.2</td>
</tr>
<tr>
<td>225</td>
<td>-18.78</td>
<td>41.3</td>
</tr>
<tr>
<td>235</td>
<td>-19.51</td>
<td>46.5</td>
</tr>
<tr>
<td>243.5</td>
<td>-22.74</td>
<td>69.6</td>
</tr>
</tbody>
</table>
warm-season grasses and perennial plants. At the top of the paleosol the vegetation had again shifted back in favor of C$_3$ plants. This shift towards warm-season vegetation in the middle of the paleosol may indicate that somewhat drier conditions prevailed at this time.

The Late Paleoindian Features
A total of 11 thermal features (F-1, F-2, F-4, F-9, F-10, F-11, F-13, F-14, F-15, F-16, and F-17) were discovered within the Broadway locality during the testing phase (see Fig. 4) and seven of these (F-1, F-2, F-10, F-11, F-15, F-16, and F-17) yielded AMS radiocarbon dates indicative of the Late Paleoindian period (Table 2). Two of the undated features (F-13 and F-14) lacked charcoal, but were in Late Paleoindian stratigraphic contexts. Feature 4, exposed in a small re-entrant gully of the arroyo ca. 45 cm below the modern ground surface, is located in a Middle to Late Holocene stratigraphic context and lacks visible carbon remains. Acacia (*Acacia* sp.) charcoal from F-9 yielded 2-Sigma date ranges of 7330–7240 cal B.P. and 7210–7170 cal B.P., indicating the presence of an Early Archaic component ca. 10–20 cm above the upper gravel bed (Puseman et al. 2013:14, Figs. 26 and 27).

Radiocarbon dates from the seven Late Paleoindian features suggest two occupational intervals, the first interval ca. 11,080–10,400 B.P. and the later interval ca. 9535–8630 B.P.—a gap of ca. 1,660 years. These intervals do not represent two separate and discrete occupations, rather a series of components within two spans of time (Fig. 8). Although tentative at this time, these two occupational intervals may correlate with two slightly different types of feature construction and hot rock technology. All of these features have basin-shaped profiles, yet the earlier features (F-1 and F-10) are more robust and lined with rocks, while the later ones (F-2, F-11, F-15, F-16, and F-17) are smaller, with single layers of FCR directly overlaying beds of charcoal. Feature descriptions and the results of associated analyses are provided below. It should be noted that profile dimensions were recorded at the location where the arroyo cut and/or backhoe trenches truncated these features and do not necessarily represent accurate maximum dimensions.

The Older Features: F-1 and F-10

**Feature 1**
Discovered in the wall of the modern arroyo that cuts through the site, F-1 is a rock-lined, basin-type thermal appliance ca. 2.3 m below the modern ground
Late Paleoindian Occupations at the Genevieve Lykes Duncan Site

Arroyo flooding appears to have removed roughly half of the feature. It has a maximum diameter of ca. 95 cm and a maximum depth of 20 cm (Fig. 9). Excavation of the feature revealed clusters of FCR as well as empty pockets or areas devoid of stone (Fig. 10). Outer edges have slight curvilinear alignments of FCR that do not seem to be a result of displacement or erosion, and the clusters of stone are interspersed with at least three empty or void areas. The areas lacking stones may have been used for placement of foodstuffs being cooked, although there is no definitive evidence of this. Heat fracturing has reduced many of the FCR into small pieces; some of the large FCR are fractured in-situ, and some of the larger stones are uncracked. These data suggest the appliance was rejuvenated and used multiple times, although differential heating due to hot-spots in the feature is a possibility. Stones within the feature consist of angular pieces of medium- to coarse-grained, indurated, tuffaceous mudrock and sub-angular fragments of probable welded tuff. The mudrock was likely collected or quarried along the lower contours of nearby hills where bedrock exposures of this material occur. Light carbon staining, small bits of charcoal, and mottled oxidized soil were encountered throughout the feature fill. Two conjoining pieces of thermally altered groundstone were discovered amongst

![Figure 8. Graph showing early and late occupational intervals of Late Paleoindian components at the Genevieve Lykes Duncan site based on conventional radiocarbon dates (RCYBP) obtained from thermal features.](image-url)
the FCR, indicating that an exhausted slab-type metate, or a fragment thereof, of an unknown igneous stone had been scavenged and re-used as a heating element.

Three charcoal samples from F-1 were submitted for AMS radiocarbon dating. The samples returned the following conventional radiocarbon ages: $9545 \pm 25$ RCYBP (PRI-10-128-CS-2), $9470 \pm 40$ RCYBP (Beta-286400), and $9420 \pm 60$ RCYBP (PRI-10-128-CS-1) (see Table 2). When calibrated, the 2-Sigma
### Table 2
Radiocarbon Data from Late Paleoindian Features Discovered at the Broadway Locality, Genevieve Lykes Duncan Site (41BS2615)

<table>
<thead>
<tr>
<th>Lab No.</th>
<th>Context</th>
<th>Wood Charcoal Dated</th>
<th>$^{13}$C/$^{12}$C Ratio †</th>
<th>Conventional Radiocarbon Age (RCYBP)</th>
<th>Calibrated Date B.C. (2-Sigma) Probability Distribution (.95)</th>
<th>Calibrated Date B.P. (2-Sigma) Probability Distribution (.95)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>PRI-10-128-CS-2</strong></td>
<td>F-1</td>
<td>Saltbush</td>
<td>−9.2 o/oo</td>
<td>9545±25</td>
<td>9130–8990 B.C.** 8930–8770 B.C.**</td>
<td>11,080–10,940 B.P.** 10,880–10,720 B.P.**</td>
</tr>
<tr>
<td><strong>PRI-10-128-CS-1</strong></td>
<td></td>
<td>Saltbush</td>
<td>−2.2 o/oo</td>
<td>9420±60</td>
<td>9150–9000 B.C.** 8850–8450 B.C.**</td>
<td>11,100–10,950 B.P.** 10,800–10,400 B.P.**</td>
</tr>
<tr>
<td><strong>PRI-11-014-85C</strong></td>
<td>F-2</td>
<td>Pecan</td>
<td>Not Reported</td>
<td>8180±30</td>
<td>7310–7070 B.C.**</td>
<td>9260–9020 B.P.**</td>
</tr>
<tr>
<td><strong>Beta-306727</strong></td>
<td></td>
<td>Unknown</td>
<td>−24.8 o/oo</td>
<td>8040±40</td>
<td>7070–6900 B.C.** 6890–6830 B.C.**</td>
<td>9020–8850 B.P.** 8840–8780 B.P.**</td>
</tr>
<tr>
<td><strong>PRI-11-014-85</strong></td>
<td></td>
<td>Saltbush</td>
<td>−3.5 o/oo</td>
<td>7934±25</td>
<td>7030–6930 B.C.** 6920–6870 B.C.** 6860–6680 B.C.**</td>
<td>8980–8880 B.P.** 8870–8820 B.P.** 8810–8630 B.P.**</td>
</tr>
<tr>
<td>Lab No.</td>
<td>Context</td>
<td>Wood Charcoal Dated</td>
<td>(^{13}\text{C}/^{12}\text{C} \text{ Ratio} \text{ †} )</td>
<td>Conventional Radiocarbon Age (RCYBP)</td>
<td>Calibrated Date B.C. (2-Sigma) Probability Distribution (.95)</td>
<td>Calibrated Date B.P. (2-Sigma) Probability Distribution (.95)</td>
</tr>
<tr>
<td>------------</td>
<td>---------</td>
<td>---------------------</td>
<td>------------------------------------------------</td>
<td>--------------------------------</td>
<td>--------------------------------------------------</td>
<td>--------------------------------------------------</td>
</tr>
<tr>
<td>PRI-11-014-92</td>
<td>F-10</td>
<td>Saltbush</td>
<td>–8.4 o/oo</td>
<td>9411 ± 33</td>
<td>8790–8610 B.C. **</td>
<td>10,740–10,560 B.P. **</td>
</tr>
<tr>
<td>PRI-11-014-73</td>
<td>F-11</td>
<td>Saltbush</td>
<td>–9.4 o/oo</td>
<td>8474 ± 27</td>
<td>7585–7510 B.C. **</td>
<td>9535–9460 B.P. **</td>
</tr>
<tr>
<td>Beta-306729</td>
<td>Unknown</td>
<td>Unknown</td>
<td>–11.8 o/oo</td>
<td>8440 ± 40</td>
<td>7580–7470 B.C. *</td>
<td>9530–9420 B.P. *</td>
</tr>
<tr>
<td>ICA-C/0428</td>
<td>F-15</td>
<td>Unknown</td>
<td>–25.0 o/oo</td>
<td>8350 ± 40</td>
<td>7520–7320 B.C. ***</td>
<td>9470–9270 B.P. ***</td>
</tr>
<tr>
<td>PRI-11-014-191</td>
<td>F-15</td>
<td>Creosotebush</td>
<td>Not Reported</td>
<td>8290 ± 30</td>
<td>7480–7250 B.C. **</td>
<td>9430–9200 B.P. **</td>
</tr>
<tr>
<td>PRI-11-014-243</td>
<td>F-16</td>
<td>Cholla</td>
<td>Not Reported</td>
<td>8355 ± 30</td>
<td>7520–7340 B.C. **</td>
<td>9470–9290 B.P. **</td>
</tr>
<tr>
<td>PRI-11-014-222</td>
<td>F-17</td>
<td>Mesquite</td>
<td>Not Reported</td>
<td>8225 ± 30</td>
<td>7350–7130 B.C. **</td>
<td>9300–9080 B.P. **</td>
</tr>
</tbody>
</table>

Note: PRI = PaleoResearch Institute, Golden, Colorado; Beta = Beta Analytic Inc., Miami, Florida; ICA = International Chemical Analysis Inc., Miami, Florida.

† Note that in some instances the \(^{13}\text{C}/^{12}\text{C} \text{ ratio} \) provided by the dating lab does not agree with the wood charcoal identification.
results of these three dates overlap during two intervals: 9100–9090 cal B.C./11,050–11,040 cal B.P. and 8830–8770 cal B.C./10,780–10,720 cal B.P. The results of the wood charcoal identifications and macrofloral analysis indicate the use of saltbush (*Atriplex* spp.) and mesquite (*Prosopis* sp.) as fuel. In addition, charred, vitrified, and friable tissue that could not be identified was noted in the samples (Puseman et al. 2013:12–13, Tables 2 and 4).

The recycled and conjoined groundstone fragments from F-1 (Specimen FS-88; Fig. 11) were submitted to PRI for starch grain and phytolith analyses. Starch grains, small granules in plants that store carbohydrates as energy reserves, are commonly preserved in grasses, legumes, and geophytes (roots and tubers). Phytoliths are the replacement of silica in and around cellular walls of plants due to the evaporation and metabolism of water absorbed through a plant’s vascular system. While the sample yielded no starch grains, numerous phytoliths were recovered and PRI suggests these represent both grasses present in the past.

Figure 11. Conjoining pieces of a slab-type metate fragment recycled for a thermal element in F-1. Photo by Richard W. Walter.
environment and plants that may have been processed with the groundstone. The environmental grasses were represented by saddle phytoliths of the Chloridoideae subfamily (ca. 55 percent relative abundance), phytoliths of the Panicoideae subfamily (ca. 10 percent relative abundance), and C_3 metabolism grasses (15 percent relative abundance) (Puseman 2013:11–12). Both chloridoid and panicoid grasses have C_4 metabolisms indicative of warm and dry environments. The former are major constituents of the shortgrass prairie (containing grasses more adaptive to xeric conditions), while the latter is typical of tallgrasses (grasses more adaptive to soils with higher moisture content and cooler seasons). The C_3 metabolism grasses represent those adapted to cool season growth (Puseman et al. 2013:12).

Only a few phytoliths identified on the groundstone fragments are suggestive of plant processing. These consisted of a single dendriform phytolith (common in the bract material of Pooidae grasses—a subfamily of the Poaceae family—that produce edible grains), four opaque perforated plate phytoliths diagnostic of sunflower family (Asteraceae) seed hulls, and a seed phytolith of the spiderwort genus *Tradescantia* (Puseman et al. 2013:11–12) (Fig. 12). Through various ethnographic accounts, both grass and sunflower family seeds are known to have been ground into powder and made into various edible substances, including bread-like cakes and mushes (e.g., Moerman 2010:65, 125). The various species of spiderwort native to the eastern Trans-Pecos/Big Bend region today are prairie spiderwort (*Tradescantia occidentalis*), Trans-Pecos spiderwort (*Tradescantia brevifolia*), and Wright’s spiderwort (*Tradescantia wrightii* variety *glandulopubescent*) (Moerman 1999). Although the ethnographic record indicates spiderwort was a valuable resource for food and medicine (Moerman 1999), little is
known about the use of its seeds (Puseman et al. 2013); however, ethnographic data indicate that a poultice of the root was mashed and rubbed over insect bites and stings and also used to bind wounds (Hamel and Chiltonoskey 1975:56–57). Thus, it is possible the F-1 groundstone was used to prepare a similar spiderwort poultice.

Two FCR samples and associated sediment from F-1 were submitted to the Palynology Research Laboratory at Texas A&M University for microfossil analysis. Although no phytoliths were recovered in any of the samples, and pollen occurred only sparingly, the sonicated residue from the FCR samples yielded eight starch granules representing three different types. Although these granules have distinctive spherical (n=6), polyhedral (n=1), and ovoid (n=1) shapes (Fig. 13), they could not be identified due to the lack of a substantial comparative starch granule collection for the eastern Trans-Pecos/Big Bend region (Riley 2012).

Only a very small number of faunal specimens were recovered from the fill of F-1, and none of these were found in-situ. They consist of tiny charred (n=2) and uncharred (n=1) bone fragments, none of which have diagnostic elements (Puseman et al. 2013: Table 2). These fragments, likely introduced into the fill after consumption, represent bones from small mammals such as mice, rats, squirrels, gophers, or rabbits.

Figure 13. Micrographs (400x) of three starch granule types recovered from FCR in F-1. Top row: spherical-shaped with some faceting; middle row: polyhedral-shaped; bottom row: ovoid with wavy cross arms (from Riley 2012: Figures 4 and 5).
Feature 10
Feature 10, a rock-lined, shallow-basin thermal feature, was exposed along the grid-north wall of BHT-9, ca. 2.5 m below the modern ground surface (Fig. 14). In profile, F-10 has a maximum width of ca. 80 cm and a maximum depth of ca. 15 cm. It is comprised of relatively large (ca. 10–12 cm diameter), subangular-to-rounded pieces of burned rock (only a few visible pieces are fire-fractured) within a light-to-moderately carbon-stained soil. The minor amount of fracturing among feature stones suggests F-10 was used only once, or perhaps a few times, prior to abandonment. Macroscopically, the lithology of the rocks appears to be welded tuff, andesite, and rhyolite of varied geochemical makeup and grain size. The roundness of the cobbles strongly suggests these rocks were collected from secondary stream load deposits of Terlingua Creek or Davenport Draw.

Wood charcoal from saltbush (*Atriplex spp.*) and mesquite (*Prosopis sp.*) is identified in a 14C sample from F-10. The saltbush charcoal yielded an AMS conventional radiocarbon age of 9411±33 RCYBP (PRI-11-014-92) (see Table 2) (Puseman et al. 2013:14, Tables 2 and 4).

![Figure 14. Profile drawing of F-10 showing FCR and carbon staining; facing grid-north. Drafting by Letitia Wetterauer.](image-url)
The Younger Features: F-2, F-11, F-15, F-16, and F-17

Only AMS radiocarbon assays and associated wood charcoal identifications were conducted on the more recent Late Paleoindian features. Feature descriptions and the results of these analyses are provided below.

Feature 2

Feature 2 is a well-defined, shallow, basin-type thermal feature exposed in the arroyo wall, ca. 4 m grid-south of F-1 and ca. 1.9 m below the modern ground surface (Fig. 15). In profile, it has a maximum width of ca. 45 cm and a maximum depth of 8 cm, and consists of 4 pieces of thermally altered stone overlying a relatively thick bed of well-preserved charcoal. Various igneous materials are represented by the feature stones which, like those in F-10, appear subangular and rounded as if collected from nearby stream load deposits.

Three charcoal samples from F-2 were submitted for AMS radiocarbon dating (see Table 2). In the sample submitted to PRI, saltbush (*Atriplex* spp.) and pecan (*Carya illinoinensis*) wood charcoal were identified and both of these were dated. The saltbush sample yielded a conventional radiocarbon age of 7934±25 RCYBP (PRI-11-014-85), and the pecan wood charcoal (Fig. 16)
Cloud, Walter, Frederick, and Mallouf provided a conventional radiocarbon age of \(8180\pm30\) RCYBP (PRI-11-014-85C) (Puseman et al. 2013:13–14, Tables 2 and 4). The third sample from the feature, this one analyzed by Beta Analytic, yielded a conventional radiocarbon age of \(8040\pm40\) RCYBP (Beta-306727). When these dates are calibrated, the 2-Sigma results do not quite overlap for all three samples; however, there are overlaps in the data (see Table 2).

A feature matrix sample from F-2 was submitted to PRI for macrofloral analysis and, like the radiocarbon sample, indicated the use of saltbush and pecan as fuel. In addition, this sample contained uncharred seeds and bone fragments, a few insect chitin fragments, and snail shells, all thought to reflect the modern biotic community based on the presence of worm casts, roots, and rootlets (Puseman et al. 2013:14). These materials may have been introduced into the feature via the arroyo wall, as the overlying gravel bed likely precluded downward movement from above.

**Feature 11**

Feature 11 is a shallow, basin-type thermal feature discovered in the southwest corner of BHT-9, ca. 5 m grid-southeast of F-2 (Fig. 17). In the grid-east portion of the trench, the feature exposure is ca. 36 cm in length; on the grid-south wall of the trench, it is 21 cm in length. It has an estimated maximum diameter of ca. 50–60 cm and, as exposed, is ca. 8 cm in maximum depth. Fire-cracked rocks comprising F-11 are clustered around the feature margins and diffusely scattered within its interior; charcoal fragments occur along its basal margin. Carbon-stained sediment is confined to a small area in the lower central portion of the feature.
Two charcoal samples from F-11 were submitted for AMS radiocarbon dating (see Table 2). Saltbush (*Atriplex* spp.) and mesquite (*Prosopis* sp.) wood charcoal were identified in the sample sent to PRI; the shorter-lived saltbush sample was chosen for dating and it yielded a conventional radiocarbon age of $8474\pm27$ RCYBP (PRI-11-014-73) (Puseman et al. 2013:14, Tables 2 and 4). The sample submitted to Beta Analytic yielded a very similar conventional radiocarbon age, $8440\pm40$ RCYBP (Beta-306729). When these two dates are calibrated, the 2-Sigma results overlap at 7580–7510 cal B.C./9530–9460 cal B.P.

**Figure 17.** Schematic drawing of F-11 in grid-southeast corner of BHT-9 showing FCR, charcoal, and carbon staining. Drafting by Letitia Wetterauer.
Features 15, 16, and 17
Within BHT-14, F-15, F-16, and F-17 occur in close proximity to one another; the two most distant are only ca. 3.7 m apart (see Fig. 4). Radiocarbon data indicate that all three features are similar in age, as the midpoints of their conventional radiocarbon ages are within 130 years of one another (see Table 2). Furthermore, the upper and lower elevations of F-15 and F-16 are identical and those of F-17 only vary from the others by a few centimeters (Fig. 18), suggesting the “paleo-surface” in this area of the site was relatively flat.

Feature 15 is a well-defined, shallow, basin-shaped thermal feature that exhibits diffuse angular and rounded pieces of FCR directly overlying a thin layer of charcoal (Fig. 19). The feature measures ca. 1.05 m in maximum diameter and has a maximum depth of ca. 10 cm. Two charcoal samples from F-15 were submitted for AMS radiocarbon dating (see Table 2). Fuel woods identified in one sample were creosotebush (*Larrea tridentata*) and friable mesquite (*Prosopis* sp.), and several other small friable fragments were identified as hardwood charcoal. The creosotebush charcoal produced a conventional radiocarbon age of 8290±30 RCYBP (PRI-11-014-191) (Puseman et al. 2013:15, Tables 2 and 4). The other sample yielded a conventional radiocarbon age of 8350±40 RCYBP (ICA–C/0428). When these two dates are calibrated, the 2-Sigma results overlap at 7480–7320 cal B.C./9430–9270 cal B.P.

![Figure 18. Schematic drawing of F-15, F-16, and F-17 (exposed in BHT-14) showing their similar elevation ranges and conventional radiocarbon dates (RCYBP). Drafting by Letitia Wetterauer.](image-url)
Feature 16 is a shallow, basin-type thermal feature that measures ca. 1.45 m in maximum diameter and has a maximum depth of ca. 11 cm (Fig. 20). It consists of a single, but discontinuous, course of FCR within an area of carbon-stained sediment intermixed with small charcoal bits. Most of the larger chunks of charcoal (ca. 4–8 cm in maximum diameter) were resting at the base of the feature. Analysis of wood charcoal indicates the use of cholla (*Cylindropuntia* sp.), creosotebush (*Larrea tridentata*), mesquite (*Prosopis* sp.), and unidentified hardwood as fuel. The shorter-lived cholla charcoal was chosen for dating (see Table 2) and it produced a conventional radiocarbon age of 8355±30 RCYBP (PRI-11-014-243) (Puseman et al. 2013:16, Tables 2 and 4).

Feature 17, exposed in a very small area at the back edge of BHT-14, contained only 3 pieces of FCR and less than 10 flecks of visible charcoal. Because of this small exposure, the feature’s morphology could not be determined. Only mesquite (*Prosopis* sp.) wood charcoal was identified in the radiocarbon sample collected from the feature (see Table 2) and it yielded a
conventional radiocarbon age of 8225±30 RCYBP (PRI-11-014-222) (Puseman 2013:16, Tables 2 and 4).

**Late Paleoindian Material Culture**

A total of 188 stone artifacts were recovered from Late Paleoindian contexts within the Broadway locality during the testing phase at the GLD site. These consist of the aforementioned two metate fragments in F-1 and artifacts recovered from the buried paleosol beneath the upper gravel bed in this portion of the site. The vast majority of these were recovered from controlled excavations (Test Units 1 and 2, and Exploration Areas C and E), while the remaining specimens were from backhoe trenches or exposures along the arroyo wall. Specimens described below consist of chipped stone tools and debitage, and groundstone.

**Chipped Stone Tools and Debitage**

A total of 184 specimens within the collection are classified as chipped stone tools or debitage. The entire chipped stone tool assemblage (n=6) consists of informal and/or expediently made tools indicative of short-term usage (Fig. 21). These are presented below under the following headings: Bifaces, Unifaces, and Edge-Modified Debitage; dimensional and other data for these specimens are provided in Table 3. Specimens with any degree of workmanship on both faces are termed bifaces, unifaces are defined as artifacts flaked on one face only, and edge-modified debitage refers to residual lithic materials resulting from tool manufacture which have edges modified through trimming and/or use. A total of 178 specimens in the collection are classified as unmodified debitage, including 3 exhausted cores.

**Bifaces (n=2)**

Two specimens in the GLD collection are classified as bifaces (Specimens FS-115 and FS-195) and both were recovered from the arroyo wall, one from the paleosol adjacent to BHT-10 (Specimen FS-115) and the other from the base of the paleosol, adjacent to BHT-9 (grid-south) and immediately above the lower gravel bed (Specimen FS-195).

Specimen FS-115 is a lateral section of an early-stage biface (Fig. 21a) and is too fragmentary for meaningful measurements and weight. Only a small portion of the lateral edge is intact and it has been ground or smoothed, presumably for further bifacial reduction; however, given the plano-convex cross
section of this edge, it is possible the grinding/wear resulted from use as an informal scraper.

Specimen FS-195 is a multifunctional bifacial tool modified from a hard-hammer flake fragment (Fig. 21b). Large, multidirectional flake removals are apparent on both faces. Although classified as a biface, the four working edges of this tool are each unifacial with plano-convex cross sections. The convex distal and proximal margins of this amorphous biface exhibit unifacial retouch and use-wear and were likely used as scrapers. Of these two opposing working edges, the bit on the distal end is longer and more extensively trimmed and utilized. In addition to these scraper edge-segments, this specimen exhibits two
large, worn concavities on opposing lateral margins, one on each face. These working edges are classified as spokeshaves, tools used for working wood or another hard material.

**Uniface (n=1)**

Only one specimen in the collection is classified as a uniface (Specimen FS-213). It was recovered from a low elevation in Exploration Area E (97.10 m), only 1–2 cm above the lower gravel bed and over 10 cm below the other lithic specimens in this exploration area.

Specimen FS-213 has a blocky angular shape with rounded corners and appears to have been detached from its parent material through natural processes (Fig. 21c). It contains thin veneers of a cortex-like covering on opposing, relatively flat surfaces, suggestive of an original bedded or layered deposition. A medium-sized pebble, it exhibits six or seven adjacent flake removals along one face of a projection, resulting in a unifacial, slightly concave-shaped edge that lacks wear.

**Edge-Modified Debitage (n=3)**

Three informal tools are classified as edge-modified debitage (Specimens FS-49, FS-65, and FS-136). These specimens were exposed in different areas of the grid-east arroyo wall; notably, the FS-65 specimen was recovered from about 10 cm above the uppermost stone in F-1. All three of these artifacts possess attributes suggestive of use on hard materials (Keeley 1980) (see Fig. 21).

Specimen FS-49 is a cortical chip with a small spokeshave bit and several small adjacent flake removals along a single recurved margin (Fig. 21e). The spokeshave contains associated step fractures, and both it and the adjacent modified edge are worn from apparent use as an expediency scraping and cutting tool.

Specimen FS-65 is a complete tertiary flake with a single, recurved modified edge situated on the back of the platform at its juncture with the dorsal surface (Fig. 21d). Modification of this specimen consists of a sequence of small flake removals, step fractures, and associated edge wear along this edge. This edge is mostly straight and, in tandem with a relatively high edge angle, suggests this portion of the tool was used for scraping purposes. Additionally, the specimen exhibits two opposing burin-like fractures that together form a pointed protrusion similar to those of dihedral burins, chiseling tools among Upper Paleolithic assemblages in Europe (Tomášková 2005). The end of the
protrusion is broken, possibly through use as a burin, but such use cannot be confidently determined.

Specimen FS-136 is a cortical chip evincing flake removals on the dorsal surface along the distal end (Fig. 21f). This modified edge is recurved and mostly dulled, presumably from use; the edge angle is high and suggests usage as an informal scraper.

**Unmodified Debitage (n=178)**

Unmodified debitage constitutes the largest artifact class in the assemblage with a total of 178 specimens. Comprised of flakes, chips, shatter, and three exhausted cores, the collection is small considering the horizontal and vertical extent of the excavations. The data presented below is predominantly from Test Units 1 and 2 (n=126), but also includes recovery from the exploration areas (n=44) and other locations along the arroyo (n=8). Analytical findings from all specimens are provided below, followed by discrete data from the test units and exploration areas.

Analysis of 175 of the unmodified debitage specimens (excluding the three cores) indicates that micro- (1–5 mm maximum diameter) and small-sized (6–20 mm) debris are dominant, constituting 89.7 percent of the collection. Seventeen specimens (9.7 percent) fall into the medium- to large-sized category (21–50 mm); one specimen (1.1 percent) has a maximum diameter >50 mm. Twelve of the specimens (6.9 percent) represent hard-hammer removals; 60 (34.2 percent) result from bifacial thinning; and 54 (30.8 percent) are pressure detachments. Given the above, it is understandable that the vast majority of specimens in the assemblage (97.2 percent) lack cortex. There is only one primary flake (0.6 percent) and two secondary flakes (1.1 percent). These data indicate that limited toolmaking from beginning stages occurred, and that most or all of the debitage is characteristic of final stages of tool manufacture and/or edge rejuvenation. The unmodified debitage collection includes seven specimens with evidence of thermal alteration and the three aforementioned exhausted cores—two of reddish varieties of indurated, tuffaceous mudrock and the other of a yellowish-brown chert. The cores are multidirectional, with one recovered from Test Unit 1 (97.70 m), one from Exploration Area E (97.45 m), and the last from BHT-11 (97.95 m).

Opaque, fine-grained, high quality chert—with homogeneous and graduated values of brown, yellow, and gray—is the dominant raw material type in the collection, comprising 53.9 percent of the specimens. The second most
common raw material is opaque, fine- to medium-grained, indurated, tuffaceous mudrock (33.7 percent) with homogenous and striated color value combinations of red and brown. The unmodified debitage assemblage contains lesser amounts of agate (3.4 percent), chalcedony (2.8 percent), quartzite (2.2 percent), jasper (2.2 percent), and rhyolite (1.7 percent). As indicated previously, all of these material types are locally available in the stream load deposits of Terlingua Creek and Davenport Draw, while bedrock outcrops of indurated, tuffaceous mudrock occur on the hills surrounding the GLD site.

Unmodified Debitage from Test Units 1 and 2

One hundred twenty-six pieces of unmodified debitage, including the afore-mentioned core, were recovered from apparent Late Paleoindian contexts in Test Units 1 and 2. These materials were uncovered from ca. 97.85 m (top of Level 17) to ca. 97.20 m (bottom of Level 29). A marked increase from only 2 recovered specimens in Level 18 (97.80–97.75 m) to 56 in Level 19 (97.75–97.70 m), coupled with the stratigraphic context of this intersection near the top of the paleosol, delineates the upper portion of the Late Paleoindian occupation zone (Fig. 22). Significant counts of unmodified debitage were also recovered from Level 20 (n=25) and Level 21 (n=21), while small numbers of specimens

![Debitage frequency per level in Test Units 1 and 2 at the Broadway locality, Genevieve Lykes Duncan site (41BS2615).](image-url)
Late Paleoindian Occupations at the Genevieve Lykes Duncan Site 51

persisted through Level 29 (97.25–97.20 m). All of the latter specimens are relatively small and could have moved downward in the stratigraphic column through natural processes, or they could simply indicate ephemeral Late Paleoindian occupations at the site.

Unmodified Debitage from the Exploration Areas

A total of 44 pieces of unmodified debitage was recovered from 4 of the exploration areas: Exploration Area B (n=1), Exploration Area C (n=9), Exploration Area D (n=1), and Exploration Area E (n=33). Since single specimens were recovered from Exploration Areas B and D, summary data for Exploration Areas C and E only are provided below.

Exploration Area C is a low bench, across the arroyo from the test units and F-1, that contained Late Paleoindian deposits. Excavation of those deposits yielded a total of nine pieces of unmodified debitage. Seven of these specimens are complete or fragmentary micro-flakes that resulted from pressure flaking. These data suggest tool finishing or refurbishing occurred in this area, while the material types represented (i.e., mudrock, agate, chert, and quartzite) indicate this activity was performed on at least four different tools or tool blanks.

Exploration Area E is a low bench, ca. 22 m down the arroyo from F-1, that also contained Late Paleoindian deposits. Thirty-three pieces of unmodified debitage, including an exhausted multidirectional core, were recovered from elevations 97.51–97.22 m during excavation of this bench. These specimens indicate more diverse tool reduction (and perhaps maintenance) activities took place in this location, as the total includes 4 hard-hammer flakes, 13 biface thinning flakes, and 3 pressure flakes. The majority of specimens (81 percent) from Exploration Area E are micro- to small-sized, 4 retain cortex, and only 2 are thermally altered. Chert is the dominant toolstone in this small collection, constituting 58 percent of the total; 30 percent of the specimens are varieties of mudrock; and single specimens of chalcedony, quartzite, rhyolite, and agate are present.

Groundstone

Two groundstone artifacts (Specimens FS-7 and FS-157) were found outside of feature contexts within the Late Paleoindian strata and, as was typical in the chipped-stone tool assemblage, these specimens exhibit only light use-wear. As mentioned previously, two conjoining metate fragments (Specimen FS-88) were among the burned stones in F-1. Descriptions and metric data of the non-feature specimens are provided below and in Table 3.
**Table 3**

Chipped Stone and Groundstone Artifact Proveniences, Attributes, and Raw Material Types from Late Paleoindian Contexts at the Broadway Locality, Genevieve Lykes Duncan Site (41BS2615)

<table>
<thead>
<tr>
<th>FS No.</th>
<th>Horizontal Provenience</th>
<th>Length (mm)</th>
<th>Max. Width (mm)</th>
<th>Max. Thickness (mm)</th>
<th>Weight (g)</th>
<th>Raw Material Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>115</td>
<td>Grid east side of arroyo wall and grid north of BHT-10</td>
<td>N/A</td>
<td>N/A</td>
<td>10.92</td>
<td>14.1</td>
<td>Banded white and pink chert</td>
</tr>
<tr>
<td>195</td>
<td>Grid east side of arroyo wall adjacent to BHT-9; just above lower gravel bed</td>
<td>68.42</td>
<td>46.67</td>
<td>12.61</td>
<td>37.7</td>
<td>Red indurated, tuffaceous mudrock</td>
</tr>
</tbody>
</table>

**Unifaces**

<table>
<thead>
<tr>
<th>FS No.</th>
<th>Horizontal Provenience</th>
<th>Length (mm)</th>
<th>Max. Width (mm)</th>
<th>Max. Thickness (mm)</th>
<th>Weight (g)</th>
<th>Edge Angle</th>
<th>Raw Material Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>213</td>
<td>Exploration Area E</td>
<td>51.66</td>
<td>46.84</td>
<td>22.75</td>
<td>54.25</td>
<td>ca. 85°</td>
<td>Striated red and pink indurated, tuffaceous mudrock</td>
</tr>
<tr>
<td>FS No.</td>
<td>Horizontal Provenience</td>
<td>Length (mm)</td>
<td>Max. Width (mm)</td>
<td>Max. Thickness (mm)</td>
<td>Weight (g)</td>
<td>Edge Angle</td>
<td>Raw Material Type</td>
</tr>
<tr>
<td>--------</td>
<td>------------------------</td>
<td>-------------</td>
<td>-----------------</td>
<td>---------------------</td>
<td>------------</td>
<td>------------</td>
<td>----------------------------------------</td>
</tr>
<tr>
<td>49</td>
<td>Grid east side of arroyo wall</td>
<td>29.73</td>
<td>26.23</td>
<td>13.3</td>
<td>14.3</td>
<td>ca. 85°</td>
<td>Graduated brown-light brown chert</td>
</tr>
<tr>
<td>65</td>
<td>TU-1</td>
<td>N/A</td>
<td>25.34</td>
<td>7.17</td>
<td>5.5</td>
<td>ca. 85°</td>
<td>Mottled dark and light gray chert</td>
</tr>
<tr>
<td>136</td>
<td>Grid east side of arroyo wall between F-1 and F-2</td>
<td>N/A</td>
<td>N/A</td>
<td>12.57</td>
<td>15.7</td>
<td>ca. 80°</td>
<td>Yellowish-brown and dark brown moss agate</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>FS No.</th>
<th>Horizontal Provenience</th>
<th>Length (mm)</th>
<th>Max. Width (mm)</th>
<th>Max. Thickness (mm)</th>
<th>Weight (g)</th>
<th>Raw Material Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>7</td>
<td>Grid east side of arroyo wall</td>
<td>260.00</td>
<td>245.60</td>
<td>97.50</td>
<td>8,890</td>
<td>Pale brown rhyolitic tuff</td>
</tr>
<tr>
<td>157</td>
<td>BHT-8 wall</td>
<td>93.97</td>
<td>66.42</td>
<td>52.60</td>
<td>444</td>
<td>Light reddish-brown rhyolitic tuff</td>
</tr>
</tbody>
</table>
Specimen FS-7
Specimen FS-7 is a slab-type metate made of a fine-grained, pale brown rhyolitic tuff. Measuring 260 x 245.6 x 97.5 mm, this tabular boulder has been expediently modified on a single face. Based on the presence of wear only on high points of this face, it is thought to have had a relatively short use-life. This specimen was recovered from a short re-entrant gully along the main arroyo, thus its chronological placement in the Late Paleoindian period is somewhat tenuous; however, its affiliation with the period is bolstered by a 14C assay of *Prosopis* sp. (mesquite) wood charcoal found immediately beneath it which yielded an AMS conventional radiocarbon age of 8330±110 RCYBP (PRI-10-128-CS-8) (Puseman et al. 2013:14, Tables 2 and 4).

Specimen FS-157
Specimen FS-157 is a unifacial, expediently ground, hand-sized mano made of a light reddish-brown rhyolitic tuff. This rounded cobble was found in the wall of BHT-8 and measures 94 x 66 x 53 mm. Limited use-wear is visible only on the high points of the specimen, indicating casual use over a short period.

Non-Feature Data and Analyses
Additional analytical data is provided below for a variety of samples recovered from non-feature Late Paleoindian contexts in the Broadway locality at the GLD site. These data consist of information from vertebrate and invertebrate samples, a pollen analysis, and four charcoal samples. With the exception of one of the charcoal samples, all were recovered from Late Paleoindian strata.

Vertebrate and Invertebrate Remains
Only a small number of faunal remains were recovered from Late Paleoindian contexts: 34 from Test Units 1 and 2; 9 from the exploration areas (7 from Exploration Area E and 2 from Exploration Area C); and 1 from BHT-9. The collection consists solely of tiny fragments—the majority are <3 millimeters in length—of burned (n=24) and unburned (n=20) bone, and all specimens lack epiphyses (i.e., the ends of long bones which are typically needed for proper identification). The majority are thought to represent small- and medium-sized mammal bones, such as those from various species of mice and rats, squirrels, gophers, and rabbits; others may be from small birds such as dove and quail. These specimens were cursorily examined by a faunal analyst, Ms. Sarah Willet, who identified a single, unburned, Leoporidae (a family of
mammals that includes rabbits and hares) tibia shaft from Test Unit 1 (Level 23—97.55–97.50 m) and two possible bird bone fragments. The latter specimens were recovered from Levels 19 (97.75–97.70 m) and 20 (97.70–97.65 m) in Test Units 1 and 2, respectively.

Conispiral and discoidal gastropod shells (i.e., snail shells) in suspected Late Paleoindian contexts were randomly collected from the test units, the exploration areas, the walls of backhoe trenches, and the arroyo. Microinvertebrate analysis of a small sample of these shells was performed by Terra Nostra Earth Sciences Research of Tucson, Arizona, and two species were identified—ram’s horn snail (*Gyraulus parvus*) and Mexico ambersnail (*Succinea luteola*)—and the researcher indicated the two of them together were indicative of an aquatic or near-shore, riparian setting in moist soils (Palacios-Fest 2011:1). Ram’s horn snails have discoidal shapes and are a shallow freshwater species, whereas the Mexico ambersnail has a conispiral shape and is a terrestrial species. Interestingly, all of the former were collected in a lower stratigraphic setting than the latter (from ca. 25 cm or less above the lower gravel bed), suggesting these deposits occurred during wetter times. It should be noted that the Mexico ambersnail has also recently been found on rocky upland flats in the Lower Pecos and in open dry grasslands in Central Texas, an indication that it is endemic to a wide range of environmental settings (Kenneth M. Brown, personal communication 2013). A controlled stratigraphic sampling of gastropods in the Broadway locality will be needed to refine these data and assist in reconstructing the paleoenvironmental record at the site.

**Pollen Analysis**

A soil sample was collected from ca. 3 cm above the topmost piece of FCR in F-1 and submitted to PRI for pollen analysis to determine the types of plants present and possibly exploited subsequent to use of the feature. Although preservation was poor in the sample, both arboreal and non-arboreal pollen grains were intact enough to be identified. Since heat destroys these grains, the researchers felt the pollen was deposited after F-1 had been used (Puseman et al. 2013:3, 11). The analysis indicated an overwhelming dominance of Cheno-am (includes the goosefoot family and amaranth) pollen, probably a reflection of locally growing plants such as saltbush. Other non-arboreal pollen types were identified in much smaller quantities, and these consist of sagebrush (*Artemisia* sp.), thistle (*Cirsium* sp.), high spine Asteraceae (includes aster, rabbitbrush, snakeweed, sunflower, etc.), two different types of Mormon tea (*Ephedra*...
*nevadensis* and *Ephedra torreyana*), wild buckwheat (*Eriogonum*), Poaceae (grass family), and Rosaceae (a member of the rose family). Trilete smooth spores (fern) were also identified in the sample. The pollen from these plants, like the Cheno-am pollen, also likely represents plants that grew in the immediate vicinity of the site. Arboreal pollen identified in small quantities consisted of juniper (*Juniperus* sp.) and pine (*Pinus* sp.), likely reflecting regional trees at higher elevations (Puseman et al. 2013:11, Figure 5, Table 5). This possibility is supported by woodrat midden data that show a progressive loss of mesic woodland species across the region during the terminal Pleistocene and early Holocene periods, except at the higher elevations (Van Devender et al. 1987:323–352).

**Other Radiocarbon Data**

Three radiocarbon samples not reported elsewhere in this article were collected from the arroyo wall at various locations in the Broadway locality (Table 4). All of these were submitted to PRI and yielded dates congruent with other radiocarbon data from the site.

One of the samples was taken from a 2–3-cm-thick charcoal and ashy lens just 4–7 cm above F-2. This somewhat broken lens extends grid-north along the arroyo wall to the southern edge of Test Unit 1, some 3.5 m (Fig. 23). Its upper extent varies in elevation from 97.79 m to 97.65 m, likely reflecting an old undulating surface at the site. Wood charcoal from this lens, identified as saltbush (*Atriplex* spp.), yielded an AMS conventional radiocarbon age of 7900±52 RCYBP (PRI-11-014-84) (see Table 4) (Puseman et al. 2013:13, Tables 2 and 4). Comparing 2-Sigma calibrated data from this sample and two samples from F-2 (i.e., samples PRI-11-014-85 and Beta-306727) suggests the lens and feature are contemporaneous.

Another charcoal sample was collected along the grid-east side of the arroyo wall at its juncture with BHT-10, ca. 11 m down the arroyo from F-1 and ca. 30 cm lower in elevation. Wood charcoal from the sample, identified as mesquite (*Prosopis* sp.), yielded an AMS conventional radiocarbon age of 9320±37 RCYBP (PRI-11-014-119) (see Table 4) (Puseman et al. 2013:15, Tables 2 and 4). Comparison of 2-Sigma calibrated data from this sample and the samples from both F-1 and F-10 suggests at least a degree of contemporaneity.

Lastly, a microcharcoal sample was secured from the lower wall of the arroyo, near its intersection with the floor and ca. 5 m upstream from F-1. This location is above and grid-east of BHT-4, a trench placed in the floor of the
Late Paleoindian Occupations at the Genevieve Lykes Duncan Site

arroyo. Importantly, it was recovered from ca. 40 cm below the lower gravel bed at an elevation of 96.45 m. Given its small size, wood charcoal identification was not possible. The sample yielded an AMS conventional radiocarbon age of 10730±150 RCYBP (PRI-11-014-55) (see Table 4) (Puseman et al. 2013:15, Tables 2 and 4), indicative of an Early Paleoindian time frame. It should be emphasized that it is currently unknown whether this sample is natural (e.g., the result of a lightning strike) or a by-product of human occupation.

Summary and Discussion
Despite long-standing efforts by archaeologists to find a Paleoindian site within the greater Big Bend region of Texas—one that was both intact and accessible for excavation—there was little success prior to discovery of the Genevieve Lykes Duncan site. In fact, only a single intact Late Paleoindian site had been previously discovered—the J. Charles Kelley site in The Basin of the Chisos Mountains—and test excavations in advance of a construction project there were relatively brief, supplying a very limited amount of data on the early components at the site. Accordingly, once the antiquity of the GLD site was

Fig. 23. Enhanced photo of the grid-east arroyo wall showing Test Units 1 and 2, the paleosol, F-1 and F-2 in profile, and the upper and lower gravel beds. Photo by Richard W. Walter; drafting by Letitia Wetterauer.
### Table 4
Late Paleoindian Radiocarbon Data from Non-feature Contexts at the Broadway Locality, Genevieve Lykes Duncan Site (41BS2615)

<table>
<thead>
<tr>
<th>Lab No.</th>
<th>Context</th>
<th>Wood Charcoal Dated</th>
<th>$^{13}$C/$^{12}$C Ratio †</th>
<th>Conventional Radiocarbon Age (RCYBP)</th>
<th>Calibrated Date B.C. (2-Sigma) Probability Distribution (.95) OxCal3.10 Cal. = P.R.I.</th>
<th>Calibrated Date B.P. (2-Sigma) Probability Distribution (.95) OxCal3.10 Cal. = P.R.I.</th>
</tr>
</thead>
<tbody>
<tr>
<td>PRI-11-014-55</td>
<td>Above BHT-4 along arroyo wall</td>
<td>Unidentified microcharcoal</td>
<td>Not Reported</td>
<td>10,730±150</td>
<td>11,050–10,200 B.C.</td>
<td>13,000–12,150 B.P.</td>
</tr>
<tr>
<td>PRI-11-014-119</td>
<td>Mouth of BHT-10 and arroyo wall</td>
<td>Mesquite</td>
<td>–35.9 o/oo</td>
<td>9320±37</td>
<td>8710–8,460 B.C.</td>
<td>10,660–10,410 B.P.</td>
</tr>
<tr>
<td>PRI-10-128-CS-8</td>
<td>Under metate along grid east side of arroyo wall</td>
<td>Mesquite</td>
<td>–8.7 o/oo</td>
<td>8330±110</td>
<td>7580–7120 B.C.</td>
<td>9530–9070 B.P.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>7110–7080 B.C.</td>
<td>9060–9030 B.P.</td>
</tr>
<tr>
<td>PRI-11-014-84</td>
<td>Charcoal lens 8–10 cm above F-2 along grid east side of arroyo wall</td>
<td>Saltbush</td>
<td>–18.2 o/oo</td>
<td>7900±52</td>
<td>7030–6640 B.C.</td>
<td>8980–8590 B.P.</td>
</tr>
</tbody>
</table>

Note: PRI = PaleoResearch Institute, Golden, Colorado.
† Note that in some instances the $^{13}$C/$^{12}$C ratio provided by the dating lab does not agree with the wood charcoal identification.
established, it was imperative that the site’s integrity and significance be determined. The testing phase, which included backhoe trenches, test units, and geoarchaeological investigations, established the site’s importance. A plethora of information was uncovered, including unique glimpses of intact thermal features, soils, and paleoenvironmental data from these ancient times.

Isolated artifacts from the Late Paleoindian period are found on the surface in the region with some regularity, ample evidence that groups from this time had more than an ephemeral or occasional presence. Yet the paucity of intact sites from the period, as well as the previous Early Paleoindian period, had archaeologists speculating that sites of this antiquity had been destroyed by erosion or were deeply buried (e.g., Campbell 1970:528; Mallouf 1986:70, 1999:56; Mallouf and Seebach 2006:125–126). In this case, the GLD location—in a headwater area of Terlingua Creek at the juncture of foothills and the lowland desert—facilitated its protection and preservation, while a modern arroyo cutting through the site allowed its discovery. The J. Charles Kelley and GLD sites, both in deeply buried and somewhat unique econiches, indicate that other intact Paleoindian sites undoubtedly are preserved in the region, but have yet to be discovered.

The GLD site is in a location that was particularly favorable to prehistoric peoples due to a combination of factors. Resting in an interfluve adjacent to Terlingua Creek, the setting afforded immediate access to water, a principal determinant for campsites in the Chihuahuan Desert. It also is situated at the juncture of an important ecotone where the terminal foothills of the Davis Mountains meet the lowland desert environs. Accordingly, prehistoric inhabitants could have targeted plants and animals endemic to each ecological zone rather easily from this location. In addition, upslope short distances from the site are outcrops of a red tuffaceous mudrock that could be fashioned into stone tools. In fact, ca. 33 percent of Late Paleoindian debitage from the site is of this material. All of these factors made the site location very suitable to Late Paleoindians who occupied it sporadically over a period of several thousand years.

Testing of the Late Paleoindian deposits at GLD has provided abundant data on the early occupants of the site and the changing environment in which they lived. Importantly, a gravel layer laid down by Terlingua Creek during a flood event about 7,500 years ago served to protect the early archaeological deposits through the ensuing millennia. As a result, both macroscopic and microscopic plant remains, including wood charcoal, are well preserved. The abundance and preservation of charcoal is particularly striking, especially
considering that the vast majority of Paleoindian sites across North America are charcoal-poor and often require the use of dating techniques other than the preferred method of radiocarbon assay. Identified wood charcoal from the features and deposits indicate that saltbush, mesquite, cholla, creosotebush, pecan, and unidentified hardwood were likely growing locally during the Late Paleoindian occupations at the site. All of these except pecan are constituents of the Chihuahuan Desert today. The modern westward extent of pecan is patchy, occurring around Del Rio, Texas, ca. 290 km east-southeast of the GLD site, but it is possible that the Late Pleistocene-Early Holocene environment along Terlingua Creek included pecan trees. It is also plausible that a piece of pecan wood procured elsewhere, perhaps as a hafted knife handle or another implement, saw its last use at the GLD site before being discarded in F-2 as fuel or waste. Thus, the existence of pecan trees near the GLD site during Late Paleoindian times will require further supporting data.

Pollen analysis from the site supplies additional evidence that many vegetal constituents of the modern Chihuahuan Desert were in place by Late Paleoindian times. A single sample, from just above and adjacent to F-1, contained both arboreal and non-arboreal pollen; the latter—dominated by Cheno-am—likely reflects locally growing plants. Other plants identified include sagebrush, thistle, members of the sunflower family, two types of Mormon tea, wild buckwheat, grasses, and a member of the rose family. Pine and juniper pollen identified in the sample probably emanated from trees growing in the region at higher elevations (Puseman et al. 2013:11, Fig. 5, Table 5). These data support other palaeoenvironmental data from West Texas and adjacent areas that suggest from ca. 14,000–10,000 B.P. the extensive woodland and parkland regions from previous times had begun to disappear, leaving only isolated pockets within an expanding scrub grassland (Wells 1966; Bryant and Shafer 1977:13; Mallouf 1981:126, 1986:70). In particular, wood rat midden data from Maravillas Canyon (at an elevation of ca. 600 m), ca. 90 km east-southeast of the GLD site, shows an increase in modern Chihuahuan Desert flora during the period from ca. 15,000 to 11,500 B.P. (Wells 1966).

Phytolith-starch grain analyses on conjoining F-1 groundstone fragments and on F-1 fill yielded only a few phytoliths and starch grains. Phytoliths adhering to the groundstone fragments were from grasses and several other plants. The grass phytoliths identified and thought to be representative of the past environment consisted of both C₄ (Chloridoideae and Panicoideae subfamilies indicative of warm and dry environments) and C₃ (indicative of cool and wet
environments) metabolisms. The fact that C₄ grasses dominate the assemblage, combined with other data from the investigation, indicates the Late Paleoindian environment at ca. 11,000 cal B.P. was well on its way to becoming the Chihuahuan Desert that we know today. Phytoliths on the fragments thought to be representative of plant processing were few in number: a Pooideae grass phytolith, four sunflower family (Asteraceae) seed hull phytoliths, and a spiderwort genus (Tradescantia) seed phytolith (Puseman et al. 2013:11–12, Fig. 6). Ethnographic accounts indicate both grass and sunflower family seeds were ground into powder and used for edible substances, and spiderwort was a valued resource for both food and medicine. While the phytoliths identified on the groundstone fragments supply additional data on the Late Paleoindian environment, the starch grains found in the F-1 fill were less informative.

Additional paleoenvironmental data comes from vertebrate and invertebrate remains. Vertebrate remains are quite fragmentary and lack epiphyses. Identified among this collection were a single, unburned rabbit or hare tibia shaft and two possible bird bone fragments. This small and fragmentary collection indicates small- to medium-sized mammals were hunted, but little else. Invertebrate species identified during the testing phase consist of the ram’s horn snail and Mexican ambersnail, evidence suggestive of moist soils in an aquatic or near-shore, riparian setting. The preponderance of paleoenvironmental data thus paints a picture of a site setting ca. 9,000 to 11,000 years ago that is very similar to what we see today, although probably wetter.

The geoarchaeological investigation at GLD provided some of our first such details for Paleoindian-aged sites in the region since the 1930s, when geologists and archaeologists collaborated during a groundbreaking investigation in the Big Bend (Albritton and Bryan 1939; Kelley et al. 1940). Findings from that collaboration aided both the discovery of the GLD site and subsequent analyses of its deposits. Three sub-areas (Mask, Broadway, and Terlingua) were delineated in the current investigation at GLD based on stratigraphy and radiocarbon data, with the central of these—Broadway—containing accessible Paleoindian deposits. Efforts in each of these localities resulted in recognition of three different aged, unconformity-bounded alluvial deposits, also known as allostratigraphic units. The earliest of these—Allostratigraphic Unit 1—contains a lower gravel bed, a paleosol with buried Paleoindian thermal features and deposits, and an upper gravel bed. Based on radiocarbon data, the unit formed prior to 10,730 RCYBP and deposition continued until sometime between 6160 and 5025 RCYBP. The unit contains a mixture of sediments derived from both
Davenport Draw and Terlingua Creek, and it is hypothesized that the former created the earlier deposits (including the lower gravel bed) and the latter was responsible for the later deposits (including the upper gravel bed).

Interesting paleoenvironmental data concerning the paleosol were also recovered. First, sedimentation rates during its formation were much lower (1.4 cm per century) than before (9 cm per century) or afterwards (5 cm per century), suggesting either Davenport Draw had moved further away from the GLD site or there was a wetter climate at this time that resulted in greater vegetative cover, less runoff, and a finer sediment load. The latter possibility—of a wetter climate during Late Paleoindian occupations at the site—may also be supported by invertebrate data and by the presence of pecan wood charcoal in F-2. In addition, stable carbon isotopic data recovered from the paleosol revealed that there was a shift from cool- to warm-season vegetation during the Paleoindian occupations. Cool-season plants and trees that favor a C$_3$ photosynthetic pathway were more dominant at both the bottom (ca. 70 percent C$_3$) and top (ca. 63 percent C$_3$) of the paleosol, whereas warm-season perennial grasses and herbaceous plants that favor a C$_4$ pathway dominated sediments deposited during the Late Paleoindian occupations.

Paleoindian sites are known for their scarcity of artifacts and the GLD site is no exception in that regard, as a dearth of stone artifacts were recovered: 184 chipped stone specimens (including 6 tools), and 4 groundstone specimens (including 2 conjoining fragments within F-1). All of the chipped stone tools are expediently made and were recovered from the paleosol along the arroyo wall, with the exception of one specimen from Exploration Area E. These consist of two crude bifaces, a uniface, and three pieces of edge-modified debitage. Significantly, one of the bifaces—an unusual multifunctional tool with unifacial working/bit edges—was recovered from the base of the paleosol immediately above the lower gravel bed; this specimen appears to have been used as a scraper and spokeshave, and predates the other tools and debitage in the collection. The majority of debitage was recovered from the test units surrounding F-1, and most of this material is classified as micro- to small-sized, suggesting they are related to late-stage tool production or refurbishment. The lack of formal chipped-stone tools may be a reflection of sampling bias (i.e., a result of hand-excavated units concentrated on F-1), and activity areas containing formal chipped-stone tools may yet be present here. It is possible that the paucity of chipped-stone tools is the result of flood-driven scouring episodes whereby artifacts were relocated but stone-armored features remained intact.
The dominance of fine-grained, siliceous stone at the site mirrors that of toolstone typically found in Paleoindian assemblages (Kelly and Todd 1988; Elyea 1988; Holliday 1997; Bouseman et al. 2004), and chert cobbles of this quality occur within the stream-load deposits of nearby Terlingua Creek. Similarly, a locally derived indurated, tuffaceous mudrock is a common toolstone in the assemblage as well, and these data suggest occupants of the site had good familiarity with the immediate setting.

The groundstone assemblage consists of a mano and a metate recovered from the paleosol along the arroyo wall, and two conjoining fragments from within F-1. The latter apparently fractured within the feature during use as a thermal heating element, and subsequent to its use as a grinding slab. It was most likely broken or discarded when placed in the feature. Both the mano and metate evince cursory use, similar to that observed on the chipped-stone tools.

Perhaps the most important findings thus far from the site are the early use of both groundstone and rock as thermal cooking and/or heating elements. These represent novel technologies associated with plant-food processing during the transition from Paleoindian to Archaic lifeways, and are some of the earliest examples in North America of such methodologies. In effect, heated stones allowed certain desert plants (e.g., desert succulents or geophytes such as sotol, agave, and lechuguilla) to be cooked at lower temperatures and for longer durations than possible in an open fire, techniques necessary to break down the complex sugars stored in the hearts of these plants (Thoms 2009). In addition, groundstone artifacts, such as metates and manos, were required to grind certain plant foodstuffs into flour-like powders to be mixed with water for further processing into consumable products. It is notable that both of these technologies are ubiquitous in the subsequent archaeological record in the Big Bend and across the continent. With such findings from the GLD site, it is reasonable to suggest one or both of these technologies may have origins in the Chihuahuan Desert.

Among the earliest such cooking and/or heating appliances in North America, the thermal features at GLD are surprisingly intact and often contain, as mentioned earlier, an abundance of charcoal. Notably, the intactness of the features and presence of charcoal are two uncommon attributes at Paleoindian sites and serve to highlight the excellent state of preservation at the site. Protected by a gravel layer from impacts due to erosion and most bioturbations for the last ca. 7,500 years, the features have yielded appreciable data concerning morphologies and contents, including information on the paleoenvironment.
Of the seven thermal features identified thus far at GLD, F-1 and F-10 stand apart from the others both chronologically and morphologically. They are the earliest at the site by over 1,000 years and also have more robust appearances than the others, containing more and larger stones. Both are within pits 15–20 cm deep, the deepest pits at the site, while the others are more shallow. Furthermore, both are similar in size with 80–95 cm maximum diameters, whereas the more recent features vary appreciably (maximum diameters of F-2 and F-11 are about 50 cm, while those of F-15 and F-16 are 1.05 m and 1.45 m, respectively). Given such variability, it is possible the earlier features had different functions than the more recent features. Importantly, since most of this data comes from profile exposures, excavation of these features is necessary to confirm or negate this possibility.

Importantly, the thermal pit features at GLD appear to represent early renditions of earth ovens, underground features where heated stones and foodstuffs were buried to allow low-heat cooking over an extended period, from a few hours to several days (Greer 1965; Black et al. 1997; Black and Thoms 2014). This technique is needed to process geophytes—plants with energy storage organs beneath the surface such as certain desert succulents (e.g., agave, sotol, and yucca)—in order to render them consumable. Earth oven remnants are common and widespread across the eastern Trans-Pecos landscape, with many consisting of large accumulations of FCR that resulted from repetitive baking episodes. Some researchers have suggested that many small, intact thermal features thought to be hearths may well have served as roasting ovens (Black and Thoms 2014).

Most radiocarbon assays of earth ovens across the Big Bend indicate origins in the terminal Late Archaic or Late Prehistoric periods (Mallouf 1985; Mallouf 2005; Davis et al. 2010). Prior to discovery of the GLD site, the CBBS had found some evidence of earth ovens from both the Early and Middle Archaic periods (Ohl 2006, 2011; Boren 2012). Subsequent to its discovery, additional evidence of this technology during the Late Paleoindian period was found at the Searcher site, only ca. 4 km up Terlingua Creek from GLD (Mallouf 2012). With a radiocarbon assay of 8140±40 RCYBP (Beta-319451), this oven is similar in age to F-2 at GLD, but appreciably larger and more robust than that feature. In fact, its morphology is more similar to Archaic and Late Prehistoric examples than the early ovens at GLD. Regardless, F-1 at GLD—in a ca. 20-cm-deep pit with concentrated, as well as areas devoid of, fire-cracked rock and with evidence of multiple uses—very possibly represents the earliest current evidence of earth oven technology in North America.
Given the somewhat sophisticated appearance of the earliest feature (i.e., F-1) at GLD, even older examples almost certainly occur in the region. Based on a host of paleoenvironmental data, Mallouf (1981, 1986) suggests early adaptations to an Archaic hunting-gathering economy in the region occurred during Late Paleoindian times in the eastern Big Bend area, and that these adaptations spread to adjacent regions from 1,000 to 2,000 years later. While the GLD site lies more in the west-central portion of the Big Bend, archaeologists should heed Mallouf’s thoughts and search for even earlier evidence of this landmark adaptation in the eastern Big Bend, where environmental parameters were most favorable for this transition.

In sum, data gathered through archaeological testing of the Genevieve Lykes Duncan site has shed appreciable light on Late Paleoindians in the greater Big Bend region of Texas from 11,000 to 9,000 years ago. In fact, prior to this investigation, archaeologists knew precious little about the entire 5,000-year-long Paleoindian period throughout this vast region. Through the testing phase, significant new data has been forthcoming on both the behaviors of Late Paleoindians and the evolving environment in which they lived. Of particular significance is the early use of plant food cooking and processing technologies, earth ovens utilizing heated stones, and grinding implements. In addition, paleoenvironmental data from the investigation has revealed that many constituents of the modern Chihuahuan Desert were present at this time, thus shedding new light on the transition to more xeric conditions during the early Holocene. While the GLD investigation unearthed a host of data and confirmed that Late Paleoindians had more than an ephemeral presence in the greater Big Bend, additional work at the site and across the region will certainly add depth and breadth to our understanding of these early inhabitants, their cultures, and their lifeways.

Acknowledgements
The authors extend sincere thanks to the owners of the 02 Ranch, Lykes Brothers Inc., for the opportunity to conduct archaeological research on this vast property over the last 15+ years. The ranch contains some of the most significant archaeological sites in the region and, through partnership of the ranch owners and the CBBS, many important research contributions have resulted. Support from Lykes Brothers Inc., including accommodations for our crews on many occasions at the 02 Ranch headquarters, has been instrumental. Special thanks go to Charles Lykes, president and chief executive officer; John Talent, now-retired vice president; and Homer Mills, ranch manager. Heartfelt gratitude goes
to Homer Mills for his discovery of the Genevieve Lykes Duncan site and his steadfast assistance and support throughout all phases of the testing project. Cameron Duncan and Genny Duncan, children of Genevieve Lykes Duncan, are gratefully acknowledged for their overall support of the project, and allowing use of their mother’s name for the site.

Due to its high level of significance, the GLD testing phase required slow, at times tedious, excavation, a host of logistical considerations, and a variety of special analyses; thus, funding for the work was critical. Many thanks are extended to the foundations and individuals who stepped forward with financial support for the project: Cameron and Susan Duncan; Genny Duncan; The Brown Foundation of Houston, Inc.; Joan and Herb Kelleher Foundation; Summerlee Foundation; Alfred S. Gage Foundation; Semmes Foundation; Coypu Foundation; Wayne and Jo Ann Moore Foundation; Orr Family Foundation; George and Cynthia Mitchell Foundation; La Brasada Foundation and the James Donnell family; Homer Mills; Kim and Annchen Lawrence; Charles Frederick; Tejon Exploration Company; and Robert and Dee Leggett. Ike Roberts, a board member of the Friends of the CBBS, is acknowledged and thanked for preparing and serving meals in the field on several occasions to donors touring the site.

The authors also extend their sincere gratitude to the GLD field crews who diligently conducted the testing project while enduring extreme climate fluctuations typical of the Chihuahuan Desert: Ashley Baker, Benny Roberts, Gena Roberts, Roger Boren, Bobby Gray, Dawnella Petrey, and Andrea Ohl. Baker, Boren, and Gray were CBBS staff members during the investigation, Petrey and Ohl were part-time employees; and Benny and Gena Roberts were our incredible, long-term volunteers from Jackson, Mississippi. As with everything involving the project, Homer Mills assisted the field crews in myriad ways, including helping with explorations along the arroyo and BHT walls and assisting with a wide variety of logistical issues. Among the latter, he constructed a protective earthen berm upslope of the site, and erected shade shelters in the Broadway locality and over a water screening area to facilitate additional excavations.

Thanks are also extended to a number of entities who assisted with the testing project. Mark Willis, a pioneer in low altitude aerial photography, contributed through his timely completion of documentation from the air prior to any groundbreaking activities. Using a remote-controlled digital camera mounted on a kite or blimp (depending on wind speeds) and photogrammetry software,
his work allowed the generation of a contoured site map that spared the field crew the tedious chore of mapping the site. Dr. Bonnie Warnock of the Natural Resource Management department of the College of Agricultural & Natural Resource Sciences, Sul Ross State University, kindly allowed the CBBS to borrow their 500-gallon water tanker to facilitate water screening during the project. The Century Trailer Company, Inc. of Fort Stockton, Texas, donated a water screening set-up or sluice to the CBBS for the project—a special design by Homer Mills—which greatly assisted this aspect of the investigation. Two separate backhoe campaigns conducted at the site went smoothly through the efforts of highly proficient and talented operators, Johnny White and Lance Jarratt.

A number of professional consultants contributed to the analytical efforts reported here and are thanked for their respective expertise and contributions to GLD research: PaleoResearch Institute, Beta Analytic Inc., International Chemical Analysis, the Palynology Research Laboratory at Texas A&M University, and Terra Nostra Earth Sciences Research. Three of the authors (Cloud, Walter, and Mallouf) would like to extend sincere gratitude to the other author, geoarchaeologist Charles D. Frederick, for his expertise and assistance throughout all phases of the project. Thanks also go to members of his top-notch geoarchaeological team, Brittney Gregory and David Yelacic, for their contributions to the investigation.

Finally, the senior author would like to thank the entire CBBS staff for their help with the project—all contributed in one manner or another. Sincere thanks are extended to senior archaeologist Robert J. Mallouf and staff archaeologist Richard W. Walter for their many efforts during all aspects of the project, including Walter’s field supervision of the site, and their contributions to preparation and editing of this article. The Center’s project archaeologist, Samuel S. Cason, is thanked for his important assistance in the field on a number of matters—mostly logistical and photography related—and for his help in drafting Figures 2 and 4. Senior project archaeologist David W. Keller surveyed the site area and adjacent environs and completed the site form. Tish Wetterauer, now-retired CBBS scientific illustrator, used her considerable talents in drafting many of the excellent figures. One of the most important staff members on the project was administrative coordinator Susan W. Chisholm, who kept track of all administrative requirements, timesheets, etc., facilitating paychecks and per diem payments; she also provided editorial assistance.
References Cited

Abbott, James T., Raymond Mauldin, Patience E. Patterson, W. Nicholas Trieweiler, Robert J. Hard, Christopher R. Lintz, and Cynthia L. Tennis

Albritton, Claude C., and Kirk Bryan

Alex, Thomas C.

1999 Archeological Data Recovery at Site 41BS908: A 9,000 Year-old Site in the Chisos Basin, Big Bend National Park. Journal of Big Bend Studies 11:1–21.

Andresfsky, William Jr.

Antevs, Ernst

Banks, Larry D. 1990 *From Mountain Peaks to Alligator Stomachs: A Review of Lithic Resources in the Trans-Mississippi South, the Southern Plains, and Adjacent Southwest.* Oklahoma Anthropological Society, Memoir 4, University of Oklahoma, Norman.


Boren, Roger

Bouseman, Britt C., Barry W. Baker, and Anne C. Kerr

Boutton, Thomas W.

Boutton, Thomas W., S.R. Archer, A.J. Midwood, S.F. Zitzer, R. Box

Bryant Jr., V.M., and R.G. Holloway

Bryant Jr., Vaughn M., and Harry J. Shafer

Buckland, Philip I.
Campbell, Thomas N.

Cason, Samuel S., and William A. Cloud

Chmidling, Catherine A.

Cloud, William A.
2012 An Update on the Genevieve Lykes Duncan Site. La Vista de la Frontera 23:1–2, 14.


Cloud, William A., and Robert J. Mallouf

Cloud, William A., and Jennifer C. Piehl
2008  *The Millington Site: Archaeological and Human Osteological Investigations, Presidio County, Texas.* Papers of the Trans-Pecos Archaeological Program 4. Center for Big Bend Studies, Sul Ross State University, Alpine, Texas.

Coffin, Edwin F.

Corkill, T.
1999  Here and There: Links between Stone Sources and Aboriginal Archaeological Sites in Sydney, Australia. Unpublished MPhil thesis, Department of Archaeology, University of Sydney.

Cummings, Linda Scott

Davis, William B.
1974  *The Mammals of Trans-Pecos Texas.* Texas Parks and Wildlife Department Bulletin 41. Texas A&M University, College Station.

Davis, Jeremy T., David H. Greenwald, Dawn M. Greenwald, Kent A. Mead, Timothy M. Mills, and Lillian M. Ponce

Dice, Lee R.
Elias, S.A.

Elias, S.A., and T.R. Van Devender
1990  Fossil Insect Evidence for Late Quaternary Climatic Change in the Big Bend Region, Chihuahuan Desert, Texas. *Quaternary Research* 34:249–261.

Elyea, Janette M.

Fenneman, Nevin M.

Fisher, R.V.

Frederick, Charles D., Brittney Gregory, and David Yelacic
2011  Late Quaternary Stratigraphic Setting of the Genevieve Lykes Duncan Site, 02 Ranch, Brewster County, Texas. Paper presented at the Center for Big Bend Studies 18th Annual Conference, November 11, 2011. Sul Ross State University, Alpine, Texas.

Geologic Society of America
Gillett, J.B.  

Goode, Glenn T.  

Greer, John W.  

Gregory, Brittney, and Charles D. Frederick  

Hamel, Paul B., and Mary U. Chiltoskey  

Handbook of Texas Online  

Harrington, M.R.  
Harris, A.H.  

Henry, Christopher D.  

Holliday, Vance T.  

Howard, E.B.  


Hughes, Philip, Peter Hiscock, and Alan Watchman  

Keeley, Lawrence H.  

Keller, David W.  
2005  *Below the Escondido Rim: A History of the 02 Ranch in the Texas Big Bend*. Center for Big Bend Studies Occasional Papers 10, Sul Ross State University, Alpine, Texas.
Kelley, J. Charles, T.N. Campbell, and Donald J. Lehmer

Kelly, Robert L., and Lawrence C. Todd

Larkin, Thomas J., and George W. Bomar

Lehmer, Donald J.

Lindsay Jr., Alexander J.

MacLeod, William

Madrid, Enrique R. (translator)
n.d. Three Expeditions to La Junta de Los Rios, 1747–1748: The Reports to the Viceroy of New Spain from Captain Commander Joseph de Ydoiaga, Governor Pedro de Rábago y Therán, and Captain Fermín de Vidaurre. Draft report in edit, Center for Big Bend Studies, Sul Ross State University, Alpine, Texas.

Mallouf, Robert J.


2001 CBBS Continues Search for Early Paleoindians in the Big Bend. La Vista de la Frontera 14:1–2.

2005 Late Archaic Foragers of the Eastern Trans-Pecos and Big Bend. In The Late Archaic Across the Borderlands, edited by Bradley Vierra, pp. 219–246. University of Texas Press, Austin.

2012 Paleoindians at the Searcher Site. La Vista de la Frontera 23:3.


Mallouf, Robert J., and John D. Seebach

Mandel, Rolfe D.

Marmaduke, William S.

Moerman, Daniel E.


Nordt, Lee C., Thomas W. Boutton, Charles T. Hallmark, and Michael R. Waters
1994 Late Quaternary vegetation and climate changes in central Texas based on the isotopic composition of organic carbon. *Quaternary Research* 41:109–120.

Ohl, Andrea J.
2006 *The Paradise Site: A Middle Archaic Campsite on the 02 Ranch, Presidio County, Texas*. Papers of the Trans-Pecos Archaeological Program, No. 2, Center for Big Bend Studies, Alpine, Texas.
Late Paleoindian Occupations at the Genevieve Lykes Duncan Site


Palacios-Fest, Manuel R.


Potter, P.E., J.B. Maynard, and P.J. Depetris


Powell, A. Michael

1994 *Grasses of the Trans-Pecos and Adjacent Areas*. University of Texas Press, Austin.

1998 *Trees and Shrubs of the Trans-Pecos and Adjacent Areas*. University of Texas Press, Austin.

2000 *Grasses of the Trans-Pecos and Adjacent Areas*. Iron Mountain Press, Marathon, Texas.

Puseman, Kathryn, Linda Scott Cummings, and Chad Yost


Riggio, Robert F., George W. Bomar, and Thomas J. Larkin

Riley, Timothy E.
2012 Microfossil Analysis of Fire-Cracked Rock Samples and Associated Sediment from the Genevieve Lykes Duncan Site (41BS2615), Texas. File document submitted to the Center for Big Bend Studies, Sul Ross State University by the Palynology Research Laboratory, Department of Anthropology, Texas A&M University, College Station.

Schmidly, D.J.

Seebach III, John D.


Thoms, Alston V.

Tomášková, Silvia

Turpin, Solveig A.
1998 *Wroe Ranch: Small Shelter Occupancy on the Edge of the Trans-Pecos, Terrell County, Texas*. Cultural Resource Report 3, Borderlands Archeological Research Unit, The University of Texas at Austin.
Urbanczyk, Kevin, David Rohr, and John C. White

Van Devender, Thomas R.

Van Devender, Thomas R., and Tony L. Burgess

Van Devender, Thomas R., R.S. Thompson, and J.R. Betancourt

Vetter, L., S.M. Rowland, and M.S. Lachniet

Wauer, R.H., and C.M. Fleming

Wells, Philip V.


Wells, Philip V., and J.H. Hunzicker

Wormington, H.M.