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Archeological Data Recovery at Site 41BS908: A 9,000 Year-old Site in the Chisos Basin, Big Bend National Park

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During the winter of 1992–1993, while monitoring reconstruction at the Chisos Basin Ranger Station in Big Bend National Park, park archeologists found the remains of a deeply stratified archeological site, 41BS908. Several discrete occupations were uncovered to a depth of 1.8 m below the ground surface. Archeological materials and pollen are well preserved within natural sediment layers. Charcoal was collected from eight hearth features at various depths and submitted for radiocarbon dating. Pollen samples were collected and analyzed. Human habitation at 41BS908 ranged from 6900 B.C. to A.D. 1830. The site has potential to yield excellent archeological information about prehistoric subsistence and use of natural resources, and substantial information about Holocene paleoclimate.

Introduction

Located in West Texas within the Big Bend of the Rio Grande, Big Bend National Park is the largest federal land area in the state of Texas and encompasses over 800,000 acres. The National Park Service (NPS) has administered Big Bend National Park since 1944. Although established as a natural area, the number of archeological sites in the park is estimated at well over 10,000, representing the last 10 millennia of human occupation. The park also contains over 450 Historic period structures related to the intrusion of European cultures into North America.

The Chisos Mountains stand as the only mountain range completely contained within the boundaries of a national park. The Chisos Basin is a broad topographic depression located in the Chisos Mountains. The Chisos range is an island of temperate environment within the surrounding Chihuahuan Desert with its spectacular scenery providing a refuge for unacclimatized visitors to the national park. These conditions attracted a great number of visitors to the park prompting the NPS to develop a campground and allow a concessionaire to construct extensive facilities in this ecologically delicate haven.

Several buildings in the Chisos Basin were built on a deposit of bentonitic clay. Bentonite, when wet, tends to swell many times

its dry volume. This can be damaging to structures built directly on the surface resulting in cracked foundations and walls, as well as doors and windows that seize. The Chisos Basin Ranger Station rests upon a grade beam supported by reinforced concrete piers sunk almost 6 m into the ground, virtually eliminating the effect of expansion in the underlying sediments. The building itself was unaffected, but the surrounding concrete walkways and patio were heaved upward by the expansion of water-saturated bentonite, creating stress cracks where the slabs were tied to the building grade beams. A contract was issued for remedial construction that involved installing trench drains under the ranger station and adjacent patio, and constructing a drain in the parking lot to intercept surface rainfall runoff before it reached the building.

In 1988, during the initial construction of the Chisos Basin Ranger Station, the prehistoric site 41BS908 was discovered but minimal evidence of archeological remains was observed. The necessary repair and reconstruction of this NPS structure in 1992 prompted archeological work which assessed the full extent and significance of the site. No special project or research funds were available and park staff performed the work with existing operating funds. This is a report of that work.

The Site Environment

The Chisos Mountains are an isolated range of rugged pinnacles and canyons with steep, wooded slopes. They were formed during a series of volcanic episodes during the Tertiary geologic period, some 30 to 35 million years ago. Igneous magma forced overlying Cretaceous sedimentary rocks upward and pushed through the resulting fractures in the earth's crust, and extruded out upon the surface in numerous locations. Since this dynamic age of crustal movement, erosion has removed over 608 m of igneous and sedimentary materials and exposed an extensive cross section of geologic history (Maxwell et al. 1967).

The dense igneous rock resisted erosion and the mountains now stand 1,520 m above the surrounding pediment. Several deep canyons dissect the mountains and one in particular forms a broad topographic basin. The Chisos Basin is a depression in the Chisos Mountains, carved by water and wind. It is ringed on the north and west by the Ward Mountain Intrusion, and on the east and south by igneous lava flows. In the depth of the Chisos Basin, erosion has

completely cut through the igneous layers and exposed Cretaceous bedrock.

During the Pleistocene Epoch climatic fluctuations further changed the earth's surface. Periods of colder climate, punctuated by episodes of more temperate weather created a rich mosaic of vegetation covering the landscape. Alpine forests of Douglas fir, Arizona cypress, Arizona pine, and other woodland species covered the slopes of the Chisos Mountains. An extensive woodland of pinyon and juniper surrounded the mountains (Van Devender 1990).

During the Holocene period, the climate has generally become warmer and drier and no longer supports these extensive mesic biotic communities. The Chisos Mountains, however, provide a cooler, moister environment harboring relict populations of Late Pleistocene flora. Stands of Arizona cypress, Arizona pine, and Douglas fir now grow at elevations between 1,824 and 2,432 m above sea level and an oak/pinyon/juniper woodland between 1,216 and 1,824 m above sea level. Arid species now cover the surrounding desert floor.

Human presence, as represented in the archeological record, can be traced within Big Bend National Park to the last 9,000 years. Site 41BS908 in the Chisos Basin is situated on an alluvial fan of rock debris eroded from the slopes of Casa Grande Peak and Toll Mountain. This fan has been dissected by a drainage that flows downward, forming a small canyon cut into the adjacent steep slopes. This dissected alluvial fan is occupied by one of the major developments in the park, including a privately owned and operated motel and restaurant concession in addition to the NPS's Chisos Basin Ranger Station (Alex 1992).

1988 Investigations

When the Chisos Basin Ranger Station was constructed in 1988, the NPS conducted a surface survey that preceded construction, and then monitored the construction project. At that time, the surface of the construction area was found to have extensive previous disturbance that included leveling of an area in 1940 for a baseball field for the Civilian Conservation Corps (CCC) work crews (James Owens, personal communication 1993). In the late 1940s and early 1950s, the ball field area became a parking lot for

the first park-related development (Ross A. Maxwell, personal communication 1986). In the early 1950s, concessionaire cabins were erected and a café was established to provide food service to visitors. The majority of NPS development was limited to the abandoned CCC camp in the lower Basin. One NPS building was located on the spot that would later be identified as site 41BS908. It was located on the north side of the old CCC baseball field. This area was later formalized when a paved parking lot was constructed by the park service in the 1960s (James Milburn, personal communication 1993; Ronald Sanders, personal communication 1993).

The 1988 construction-monitoring project recorded two poorly developed soil strata containing scattered lithic debitage, but no other significant cultural materials. Soil profiles drawn at the time recorded at least two layers of fill dirt lying on top of a pre-1940s humic soil surface. The excavation for grade beams for the ranger station foundation reached a maximum depth of 90 cm below the existing ground surface. Three pieces of debitage and no intact archeological features were observed at that time. This scant evidence was insufficient for designating the area as a significant archeological site but was sufficient to prompt monitoring during later construction projects.

1992–1993 Investigations

In November 1992, the NPS archeologist inspected the construction site for archeological evidence. The trench drains beneath the building were dug into construction backfill where no cultural materials were observed. The trench drains in the patio area were excavated into apparently undisturbed sediments and exposed chipped-stone material. This stratum was sampled for additional cultural evidence.

A crew of two NPS employees and three volunteers was assembled to sample the sediment being exposed by construction. The original construction plans depicted topographic elevations relative to mean sea level, and so these plans were used to establish vertical elevation control datum points around the building. Vertical and horizontal measurements were referenced to the building grade beam, thus minimizing the shrink-swell effect of the bentonite-rich sediment. Ten shovel tests of the upper 20 cm of undisturbed sediment in the patio area recovered an average debitage density of 60 specimens per cubic meter. No diagnostic artifacts were recovered in these tests and no cultural features were observed.

Monitoring of Construction Backhoe Trench

On November 30, 1992, the contractor began backhoe excavation of a trench for a parking lot drain. The water was to be intercepted at the parking lot by a grated inlet covering a concrete box. A corrugated metal pipe 46 cm in diameter placed at the bottom of the box would carry the water northward around the east side of the ranger station building and release it north of the area. A small field crew consisting of the park archeologist, a field assistant, and three volunteers monitored the construction project.

The fieldwork began with recording sediment profiles at 5-m intervals along the backhoe trench and collecting samples for sediment texture analysis. Chipped-stone debitage was observed and recorded in situ within the upper 40 cm of natural sediment.

Low in the trench wall, where the trench passed closest to the ranger station, the backhoe cut across the edge of a stone-paved hearth (Feature 1), exposing fire-cracked rock and charcoal. The trench depth at that location was 180 cm below ground surface and the feature was discovered at a depth of 110 cm below the top of the natural sediment.

Trench excavation continued to the edge of the parking lot where two more features were exposed. An on-site meeting between the project archeologist and the contractor halted construction work in the trench and laid a strategy for archeological test excavation. In the interim, the contractor focused his construction work at the patio area.

With the discovery of the concentration of chipped stone in the patio area and the discovery of Feature 1 in the trench, it was clear that the site contained significant quantities of cultural material and warranted compliance with the National Historic Preservation Act (NHPA). According to the requirements of Section 106 of the NHPA, an excavation and data recovery plan was submitted to the NPS Southwest Regional Office in Santa Fe, New Mexico. A major goal in this strategy was to maximize the data recovery and minimize the delay of construction work.

Excavation of the feature commenced with a strategy to excavate into the trench wall above Feature 1, then excavate down onto the top of the feature. The purpose was to expose a portion of the feature, confirm that it was a hearth, obtain an estimate of its size, and begin recovery of charcoal for a radiometric age determination. A column of sediment samples was collected from the trench wall 1 m north of Feature 1 for use in sediment texture and fossil pollen analysis. A 90-x-45-cm area, or approximately one-third of Feature 1, was exposed by controlled excavation.

Two other fire-cracked rock features were exposed by the backhoe at the southern end of the trench and designated as Features 2 and 3. Feature 2 consisted of fire-cracked rock and charcoal lying at the contact between the top of natural sediment and the bottom of the lowest layer of fill dirt. Despite the disturbance of the original sediment surface at this contact, charcoal was observed in abundance where it was exposed in the end of the backhoe trench. Feature 3 was a 20-cm thick layer of fire-cracked rock lying about 50 cm below Feature 2. Both Features 2 and 3 stratigraphically lie above Feature 1. A projectile point preform of probable Archaic age was recovered from the trench wall 5 m north of, and stratigraphically between, Feature 2 and Feature 3.

Excavation of 6.25-m^2 Unit

The construction schedule called for installing the parking lot drop inlet by the end of December 1992, which provided a three-week window during which excavation could proceed without causing delay to the contractor. The contractor cut through the overlying asphalt to expose the underlying strata and NPS archeologists began a controlled excavation of the area that was to be disturbed by construction of the concrete drop inlet box. This excavation was approximately 2.5 x 2.5 m and was excavated to a depth of approximately 1.8 m and is referred to here as the 6.25-m^2 unit.

Vertical control was tied to a nearby survey monument, and local elevations were recorded and converted to elevation above mean sea level. Excavation proceeded with vertically controlled 10-cm levels. The density of the clay-rich sediment made hand excavation by trowel unacceptably difficult and slow. The 10-cm levels were loosened with picks and shovels and then water-screened.

Attention was paid to changes in proportions of clay, sand, and small pebbles within each level as indicators of natural or cultural stratigraphic markers. The walls of adjacent unexcavated subunits were inspected throughout the excavation to detect subtle but significant variations in sediment consistency and content. Hearth features were excavated separately as individual units. Attempts were made to expose a sufficient portion of each feature to determine morphologic characteristics. Features were excavated by trowel even though the dense clay sediment proved very resistant to removal.

Stratigraphy

Below the parking lot asphalt was a layer of road base and a layer of sub base (Figure 1). Beneath these road construction layers were two layers of fill material. The lower layer of fill material contained glass and metal objects probably related to the use of the area during the CCC and later NPS periods. The fill material was thoroughly mixed and rock fragments within it were unsorted.

The top of the natural sediment was a truncated surface covered by the lower layer of distinctive fill material. The truncated surface dipped to the west (also the direction of the natural grade) and dropped 10 cm lower on the west side of the unit. Fire-cracked rock from Feature 2 rested on that surface and was covered by the construction fill material. The color of the natural sediment remained consistent with depth. However, subtle changes in texture and content were noted during excavation of the unit.

Level 1 began at the top of the natural sediment surface in the southeast corner of the unit and extended downward 10 cm. Feature 2 rested in a sediment that contained a pebbly concentration near the surface and became less pebbly downward. This is typical of gravel pavement development on a deflated surface where fine particles are removed by weather and leaving the larger stone particles to settle downward. Human activity will also hasten this formation by loosening the sediment and opening it to swifter deflation and compress the stones into the living surface. Similar apparent stable surfaces were found in Level 4 and sloping from Level 7, westward down into Level 8. Another faint pebble concentration was found in Level 11. Pebbles increased below Level 12, and Level 14 contained gravel concentrations.

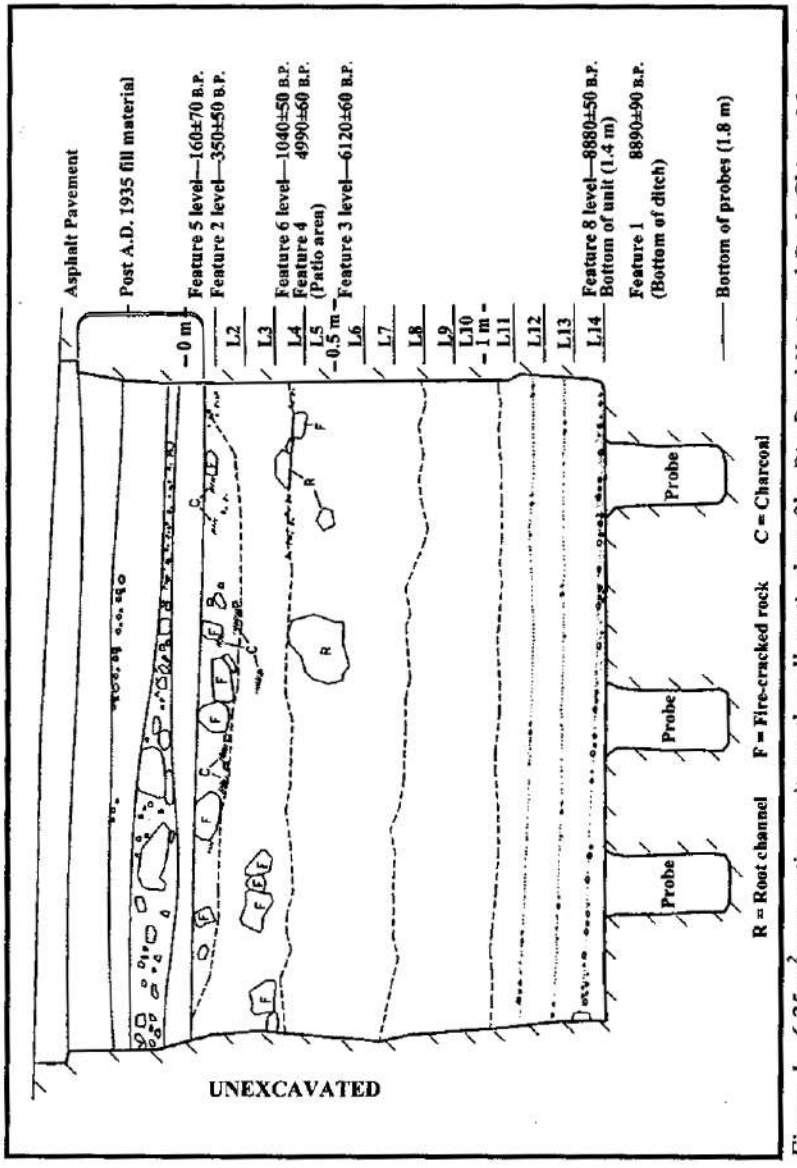

Figure 1. 6.25-m² excavation unit, south wall vertical profile, Big Bend National Park Chisos Mountains Upper Basin site 41BS908.

Sediment color, as determined by Munsell Soil Color Chart, did not change, but subtle changes in silt, sand, and clay content were visually observable when the sediment was slowly troweled. These texture changes made subtle variations in color shading. The effect of light or shade falling on the sediment also affected the detection of these variations.

The penetration of roots from the modern surface was evident in the upper seven levels. The root channels were marked by wood fragments or sandy texture, similar to overlying sediments. The more recent penetrations were evident from the loose sediment fill. The charcoal within the root channels may have been carried down from overlying hearth features, but it is more likely that these were roots from burned trees. Toward the surface, charcoal was much more abundant as would be the case if trees were not fully burned and the root system rotted in place. Charcoal from the burned root crown will fall downward into the root channels as they rot and charcoal concentration diminishes with depth. This was apparent in most root channels observed. Other root channels exhibited only sediment fill and no charcoal flecking.

Special samples were collected, including carbonaceous material for radiometric dating, and sediment for texture and fossil pollen analysis. Thermally altered rock samples were retained from each feature for possible future thermoluminescence dating.

Hearth Feature Descriptions

Hearth features were excavated as cultural units. The removal of the matrix from between fragments of hearthstones was done with a variety of trowels, spoons, brushes, and dental picks. As hearthstones were removed, care was taken to collect charcoal, and to map the location of stones prior to their removal. The purpose was to record the construction sequence of hearths and create a complete view of hearth morphology. The construction of most hearths apparently began as broad shallow pits that were carefully lined with stones and then filled with loosely layered rock. Charcoal was found in abundance in all hearths. Charcoal and ash tend to settle and filter toward the bottom of the hearth. Charcoal samples were collected from the matrix within the lower half of the hearth whenever possible to reduce the potential contamination from charcoal that may filter downward from overlying features.

Feature 1

Feature 1 was a stone-paved hearth approximately 1.2 m in diameter. It was probably circular to oval in plan view and exhibited a central depression approximately 20 cm lower than its periphery. Charcoal was found in increasing abundance toward the lower part of the central depression. No root contamination was apparent and charred wood material was collected for analysis. The radiocarbon age for this feature is 8890±90 years B.P.

Feature 2

Feature 2 was a large accumulation of stone exhibiting thermal alteration, and lying within a matrix of ashy sediment and charcoal. The leveling of the area for the CCC baseball field apparently disturbed the upper 5 cm of the feature. Charcoal was collected from the lower 10 cm of Feature 2 and later returned a radiocarbon age of 350±50 years B.P.

Feature 3

Feature 3 was a broad, shallow basin 1 m in diameter, lined with a layer 20-cm thick, closely clustered fire-cracked rock, and contained abundant charcoal. It was about 50 cm below Feature 2. The complete morphology of this feature was not recorded because, unfortunately, the backhoe removed the center of it in one scoop. Charcoal and ash-bearing sediment from the periphery returned a radiocarbon age of 6120±60 years B.P.

Feature 4

While excavation proceeded in the 6.25-m^2 unit, the contractor exposed cultural materials in the patio area. Our small field crew was divided to handle this discovery. Feature 4 was located in the patio area near the ranger station flagpole. Post-1930 fill lay atop the natural sediment. The original surface had been truncated at some time, possibly during leveling of the area for the CCC baseball field or for the 1960s parking lot construction. This remedial construction project exposed scattered fire-cracked rock in the patio area. Two shovel tests were dug to determine the depth of this feature and the core of the hearth was discovered. Feature 4 lay buried about 15 cm below the top of the original surface. Feature 4 was partially dismembered and a scattering of fire-cracked rock extended eastward from the core of the hearth for a distance

of 1.5 m. A small radiocarbon sample recovered from the feature later dated to 4990±60 B.P.

Feature 5

In the northeastern corner of the 6.25-m^2 excavation unit, within 10 cm of the modern surface, Feature 5 was encountered. It was stratigraphically associated with Feature 2. This feature was another cluster of fire-cracked rock within a matrix of ashy, charcoal-flecked sediment. The portion of Feature 5 exposed within the excavation unit was sampled and a radiocarbon age was later returned of 160±70 years B.P.

Feature 6

Within the 6.25-m^2 unit, as excavation continued below Feature 2, Feature 6 was encountered. It was located within Levels 3 and 4. This hearth was a small, shallow pit, lined with rock. The feature was 45 cm in diameter, and consisted of a circular accumulation of fire-cracked rock filling a pit 16 cm deep, and contained a matrix of ashy sediment and charcoal fragments. The matrix texture was a pebbly clay loam, with calcium carbonate skins on the pebbles. Charcoal obtained from the feature returned a radiocarbon age of 1040±50 years B.P.

At the northwest edge of Feature 6, atop an apparent living surface, was a flat rock slab metate, measuring 42 cm long, 29 cm wide, and 10 cm maximum thickness. A sediment sample was taken from directly beneath this slab for later fossil pollen analysis.

Feature 6 was embedded within a thin pebbly deposit that marked a deflated surface. Near the north edge of Feature 6, at about 15 cm deep within the deposit, an unfinished dart point fragment was recovered. The point fragment is of a type identified by Taylor (1966) as Jora. The type is associated with the Early and Middle Coahuila complex, an Archaic cultural period of northern Coahuila, Mexico (Taylor 1966). This artifact was made of locally available hornfels and was left incomplete due to a transverse snap fracture that apparently occurred during manufacture. The tentative age of this artifact falls within the Middle Archaic, (3000–1000 B.C.). Less than a meter north of this artifact and stratigraphically equal, was the base of another dart point having simi-

lar morphology to Langtry, also a Middle Archaic projectile point type (Bement 1991).

The presence of Middle Archaic artifacts within the sediments into which Feature 6 was excavated, suggests that a Middle Archaic age ground surface was reoccupied by a later group who constructed and used the Feature 6 hearth. These two artifacts are contextually framed between Features 6 and 3. The associated radiocarbon ages place the projectile points within their expected temporal association.

Feature 7

Feature 7 was a dismembered hearth remnant discovered in the wall of the backhoe trench. It was exposed during construction of a second concrete drop inlet box near the east corner of the ranger station. The feature was a loose concentration of fire-cracked rock and contained no charcoal or ash. The feature was mapped, but no special samples were collected.

Feature 8

Excavation of the 6.25-m^2 unit continued to a depth of 140 cm below the natural sediment surface. Within Level 14 (130–140 cm below the natural surface) the excavation encountered a small cluster of fire-cracked rock which apparently was the remains of an eroded hearth. Fire-cracked rock was found within the surrounding sediment, but the pattern suggested that the feature was severely eroded. Sufficient charcoal was present at the bottom of the feature and it was collected. Carbonaceous material from the intact remains of this feature returned a radiocarbon age of 8880±50 years B.P.

Excavation continued to a depth that was sufficient for the construction of the concrete drop inlet box of the parking lot drain. A posthole digger was used to probe an additional 40 cm below Level 14 and the probes encountered chipped stone debitage and fire-cracked rock to a depth of 180 cm below the natural soil surface. The total depth of this site remains undetermined.

Radiometric Dating

Carbonaceous materials recovered from site features were first prepared by park staff, then shipped to Beta Analytic, Inc. of Coral Gables, Florida, for processing and analysis. At the park,

each sample was handled using accepted methods of conservation and treatment. Sterile tools were used to collect the specimens in the field. Samples were packaged in heavyweight aluminum foil pouches and labeled with the sample provenience. Once the samples arrived in the laboratory, they were inspected and cleaned. Rootlets and dirt were removed to the degree practicable. Each sample was then repackaged according to the requirements of Beta Analytic, Inc.

Beta Analytic technicians further prepared the samples for radiocarbon dating and C^{13} fraction analysis using standard procedures. Beta processed three samples, and Lawrence Livermore Laboratories processed four small samples by using the Atomic Mass Spectrometry (AMS) method. The radiocarbon ages are reported in Table 1 and reflect C^{13} adjusted radiocarbon ages.

Palynological Study

A sediment column was collected from the southeast corner of the 6.25-m^2 excavation unit, from Subunit I, at the east end of the south wall. The top of the column began at the juncture between the base of construction fill and the top of the natural sediment, a control depth corresponding to the top of excavation Level 1. The bottom of the column was the base of the excavation unit at 140 cm below the top of natural sediment. Samples were taken at 5-cm intervals and were separately bagged.

These samples were submitted to Texas A & M University for an assessment of potential for preservation of fossil pollen in the sediment at the site. At the time, the NPS had no funding available for analysis of the full complement of samples. Dr. Vaughn Bryant arranged for the gratis processing of eight of the 31 samples. Doctoral candidate John N. Miller examined them, with surprising results.

First, fossil pollen can indeed be recovered from the site. Miller's (1993) preliminary pollen counts show that there are significant amounts of economic pollen present in some of the samples collected from features (Table 2). *Dasylirion* associated with Feature 6 suggests that sotol processing or consumption was part of the Late Archaic pattern. Concentration values are higher than those that can be obtained from normal surface samples, even surface samples collected directly beneath a flowering plant. This suggests that humans were using these plants and that this use re-

Table 1
41BS908 Radiocarbon Analysis Results

Sample Number	BIBE Sample Number	Provenience	C^{13}/C^{12}	C^{13} Adjusted Age (Before Present)	2-σ Calibrated Age
B-70863	908-801	Feature 5 hearth; 6.25-m^2 unit, Level 1	-25.7‰	160±70 B.P.	A.D. 1640–1950
B-70860	908-795	Feature 2 hearth; 6.25-m^2 unit, Level 2	-26.4‰	350±50 B.P.	A.D. 1440–1660
C-12214	908-803	Feature 6 hearth; 6.25-m^2 unit, Level 3	-22.9‰	1040±50 B.P.	A.D. 1100–1110
B-70862	908-800	Feature 4 hearth; patio area	-25.4‰	4990±60 B.P.	3950–3660 B.C.
C-12213	908-799	Feature 3 hearth; 6.25-m^2 unit, Level 5	-22.6‰	6120± 60 B.P.	5220–4910 B.C.
C-12215	908-804	Feature 8 hearth; Level 14	-25.5‰	8880±50 B.P.	8030–7730 B.C.
C-12212	908-785	Feature 1 hearth; Bottom of ditch	-26.2‰	8890±90 B.P.	8080–7700 B.C.

Samples numbered B-nnnnn are standard samples measured by Beta Analytic, Inc., Coral Gables, Florida.
Samples numbered C-nnnnn are AMS dates measured by Lawrence Livermore National Laboratory (CAMS) in California.

Table 2
Pollen Counts for Site 41BS908, Chisos Basin, Big Bend National Park

	Levels					Features		
Taxon	1A	3A	4A	8A	14A	Feature 6 Sample A	Feature 6 Sample B	Near F-6 beneath metate
Pinus, total	28	7	6.3	10.3	1.6	10.6	8.6	6
Pinus, haploxylon (pinon)	2			1		3		
P. ponderosa (diploxylon)	3	3					1	1
Pinus spp.	23	4	6.3	9.3	1.6	7.6	7.6	5
Cupressaceae	1		1			2		
Acacia			1	1		1		
Acer	1		1		2			
Celtis				3		3		
Maclura pomifera				1				
Quercus							1	
Prosopis	1	1						
Salix			3	3		4	2	3
Ulmus	2							
Ephedra, torreyana type	1	4	2	4	2	2	2	2
Ephedra, nevadensis type	4					2		
Poaceae	21	18	7	18	6	37	13	23
Cyperaceae				8	1	4	2	1
Low spine Asteraceae	15	18	29	13	26	17	23	15
High spine Asteraceae	1	1	3	1				1
Artemesia type			2	4	3	4	3	4
Linguaflorae type						3		
Cheno-ams	80	125	116	105	138	82	117	107
Agave					1			
Amaryllidaceae, other							1	
Allium	1			2	2		4	
Dasylirion		1		2	2	5	8	10
Nolina						1		
Liliaceae, other							1	3
Opuntia spp.		2	1			1		2
Opuntia, platyopuntia type					1	2		
Opuntia, cylindropuntia type								
Cactaceae, other	1					3		
Ericaceae						1	1	
Portulaceae							1	
Typha latifolia			1					
Vitaceae				2				
Unknown 1	21	7	7	6	4	6	3	6
Unknown, others	2	4		2	1			1
Indeterminate	24	23	20	20	11	15	10	21
Raw Count Totals	204	211	200.3	205.3	200.6	205.6	200.6	205
Lycopodium	8	10	2	5	5	3	1	6
Pollen Concentration	14408	11922	56585	23199	22668	38721	113339	19304

ordered the fossil pollen record that would naturally exist otherwise. This should be checked to determine how and why these pollen types are present in such high quantities. There is also a high diversity of pollen taxa represented in the samples studied.

Relatively high percentages of Cheno-am suggest a pattern of low water tables and channel erosion in the Basin for 3,000 to over 6,000 years (Tables 3 and 4). This led Miller (1993) to a very ten-

tative paleoenvironmental interpretation of warmer, more xeric conditions at 8800 B.P. (Level 14A) followed by an increase in moisture between +7000 B.P. (age interpolated at Level 8A) to 1000 B.P. (age inferred by radiocarbon date from Feature 3), ending with a cooler, more mesic environment in most recent time (inferred by radiocarbon date from Features 2 and 5 at Level 1). This interpretation is based on the comparison of *Pinus* to Cheno-am.

Table 3
Pollen Percentages for Site 41BS908, Chisos Basin, Big Bend National Park

	Levels					Features		
Taxon	1A	3A	4A	8A	14A	Feature 6 Sample A	Feature 6 Sample B	Near F-6 beneath metate
Pinus, total	13.7%	3.3%	3.1%	5.0%	0.8%	5.2%	4.3%	2.9%
Pinus, haploxylon (pinon)	1.0%			0.5%		1.5%		
P. ponderosa (diploxylon)	1.5%	1.4%					0.5%	0.5%
Pinus spp.	11.3%	1.9%	3.1%	4.5%	0.8%	3.7%	3.8%	2.4%
Cupressaceae	0.5%		0.5%			1.0%		
Acacia			0.5%	0.5%		0.5%		
Acer	0.5%		0.5%		0.5%			
Celtis				1.5%		1.5%		
Maclura pomifera				0.5%				
Quercus							0.5%	
Prosopis	0.5%	0.5%						
Salix			1.5%	1.5%		1.9%	1.0%	1.5%
Ulmus	1.0%							
Ephedra, torreyana type	0.5%	1.9%	1.0%	1.9%	1.0%	1.0%	1.0%	1.0%
Ephedra, nevadensis type	2.0%					1.0%		
Poaceae	10.3%	8.5%	3.5%	8.8%	3.0%	18.0%	6.5%	11.2%
Cyperaceae				3.9%	0.5%	1.9%	1.0%	0.5%
Low spine Asteraceae	7.4%	8.5%	14.5%	6.3%	13.0%	8.3%	11.5%	7.3%
High spine Asteraceae	0.5%	0.5%	1.5%	0.5%				0.5%
Artemesia type			1.0%	1.9%	1.5%	1.9%	1.5%	2.0%
Linguaflorae type						1.5%		
Cheno-ams	39.2%	59.2%	57.9%	51.1%	68.8%	39.9%	58.3%	52.2%
Agave					0.5%			
Amaryllidaceae, other							0.5%	
Allium	0.5%			1.0%	1.0%		2.0%	
Dasylirion		0.5%		1.0%	1.0%	2.4%	4.0%	4.9%
Nolina						0.5%		
Liliaceae, other							0.5%	1.5%
Opuntia spp.		0.9%	0.5%			0.5%		1.0%
Opuntia, platyopuntia type					0.5%	1.0%		
Opuntia, cylindropuntia type								
Cactaceae, other	0.5%					1.5%		
Ericaceae						0.5%	0.5%	
Portulaceae							0.5%	
Typha latifolia			0.5%					
Vitaceae				1.0%				
Unknown 1	10.3%	3.3%	3.5%	2.9%	2.0%	2.9%	1.5%	2.9%
Unknown, others	1.0%	1.9%		1.0%	0.5%			0.5%
Indeterminate	11.8%	10.9%	10.0%	9.7%	5.5%	7.3%	5.0%	10.2%
Raw Count Totals	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%

Table 4
Pollen Percentages for Select Taxa, Site 41BS908
Chisos Basin, Big Bend National Park

	Levels				
Taxa	1A (160–350 B.P.)	3A (±1000 B.P.)	4A	8A (±7000 B.P. inferred)	14A (9000 B.P.)
Arboreal, Pines	13.7%	3.3%	3.1%	5.0%	0.8%
Arboreal, other	2.5%	0.5%	3.0%	4.0%	0.5%
Total Arboreal	16.2%	3.8%	6.1%	8.9%	3.0%
Poaceae (grasses and sedges)	2.5%	1.9%	1.0%	1.9%	1.0%
Asteraceae (composites)	7.9%	9.0%	17.0%	8.7%	14.5%
Cheno-ams (goosefoot and amaranths)	39.2%	59.2%	57.9%	51.1%	68.8%
Amaryllidaceae and Liliaceae with *Dasylirion* (agaves, sotol, yucca, etc.)	0.5%	0.5%		1.9%	2.5%
Cactaceae (cactus)	0.5%	0.9%	0.5%		0.5%
Amaryllidaceae, Liliaceae, and Cactaceae	1.0%	1.4%	0.5%	1.9%	3.0%

This appears to conflict with paleoclimatic reconstructions from other disciplines. Van Devender's (1990) fossil neotoma midden studies from the southwestern deserts infer a woodland blanketing the desert surrounding the Chisos Mountains, which gradually retreated during the Holocene, to the higher elevations where cool, moist conditions favored survival of coniferous taxa. Douglas fir, Arizona pine, and quaking aspen grow today in the Chisos Mountains, but only in the shelter of moist montane canyons and north-facing slopes.

The percentage of indeterminate taxa from this pollen study (Miller 1993) accounts for from 5.5 to 11.8 percent of the total from each excavation level (see Table 3). Miller's (1993) Unknown 1 taxon is suspected of being *Populus* sp. No cottonwoods grow in the high Chisos Mountains but relict populations of *Populus tremuloides* (quaking aspen) survive on the highest slopes of Emory Peak and in a small stand of eight individuals in the lower Chisos Basin. Unknown 1 may indeed be degraded specimens of *P. tremuloides*, accounting for an additional 2.0 to 10.3 percent of arboreal taxa. Applying these arboreal percentages to the total of recognized arboreal totals significantly increases the percentage of arboreal taxa during the earlier Holocene.

An evaluation of these data by Dr. Vaughan Bryant, who oversaw the work of Miller, cautioned against an inference of paleoclimatic conditions due to the small sample size analyzed. In addition, the apparent inverse ordering in the relative proportions

of arboreal pollen can be explained in part by considering postdepositional alteration of the fossil record by natural processes.

Bryant et al. (1994) have addressed the problem of postdeposition degradation of specific pollen types for alkaline soils in the American Southwest. Factors such as mechanical degradation, soil pH, and oxidation potential can cause destruction of select pollen taxa. Their study also points out that some taxa of *Phycomycetes* fungi and *Actinomycetes* bacteria attack pollen grains, causing their eventual premature destruction.

Certain species of coniferous trees, especially *Pseudotsuga* (Douglas fir), were attacked much more frequently by *Phycomycetes* fungi than were types of angiosperm pollen (Bryant et al. 1994). Pollen from many conifer taxa are the most susceptible types to fungal infection, and thus by inference, eventual destruction. This premature destruction of these taxa in the fossil record can result in their absence from the total fossil pollen assemblage and the erroneous conclusions that certain arboreal taxa were not present during certain time periods.

Although this pollen study is preliminary, it suggests that future analysis of the full spectrum of samples recovered from the site might clarify the preliminary results. Future research at this site has potential to yield data that illuminates the Holocene vegetation in the Chisos Mountains.

Hearthstone Analysis

Hearthstone analysis included recorded measurement of the weight in kilograms, maximum and minimum dimensions in centimeters of each stone fragment, the number of fire-fracture facets, the presence of observable thermal color change, and the type of stone. Preliminary analysis indicates there was no preference for stone type; the people apparently used whatever was readily available. This interpretation is tentative based on a cursory observation of stone types available on the slopes adjacent to the site. Controlled sampling of the available stone material would add more support to this interpretation.

Discussion

The study of this site has contributed to a better understanding of prehistoric lifeways in the Big Bend region of Texas. The presence of a stratified record of human occupation for a 9,000 year span is significant. The stacking of radiocarbon ages from hearth features indicates a gradual deposition of approximately 1.5 m of sediment during the past 9,000 years. Periods of surface stability and probable slight erosion are indicated by thin accumulations of small gravels and compacted sediment as well as by the presence of campfire features located atop those surfaces.

Fossil pollen is well preserved within the site and has potential to greatly enrich the understanding of changes within the Holocene vegetation communities that have existed in the Chisos Mountains. Study of the pollen record on other sites within similar situations in the Chisos Mountains has potential to yield patterns in human subsistence activity and environmental exploitation.

And finally, because this site has contributed greatly to the scientific understanding of the prehistory of the Big Bend, it is fitting that it be named in honor of one of the outstanding archeologists of the region. Dr. J. Charles Kelley worked in Big Bend National Park in the 1930s during the initial survey and testing of sites found during the CCC era (Ruel 1936; Cook 1937; Kelley 1986). His research into prehistoric lifeways helped frame the cultural interpretation of archeological remains in Trans-Pecos Texas. Site 41BS908 is henceforth named the J. Charles Kelley site in recognition of Dr. Kelley's contributions to science.

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