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Back cover: Excavations at Antelope Cave; Front cover: (left) Pueblo I style sandals from the UCLA Antelope Cave collection.; (right) Square Toe Cordage sandals 244-2460 and 2461 (photos by Laurie Webster)

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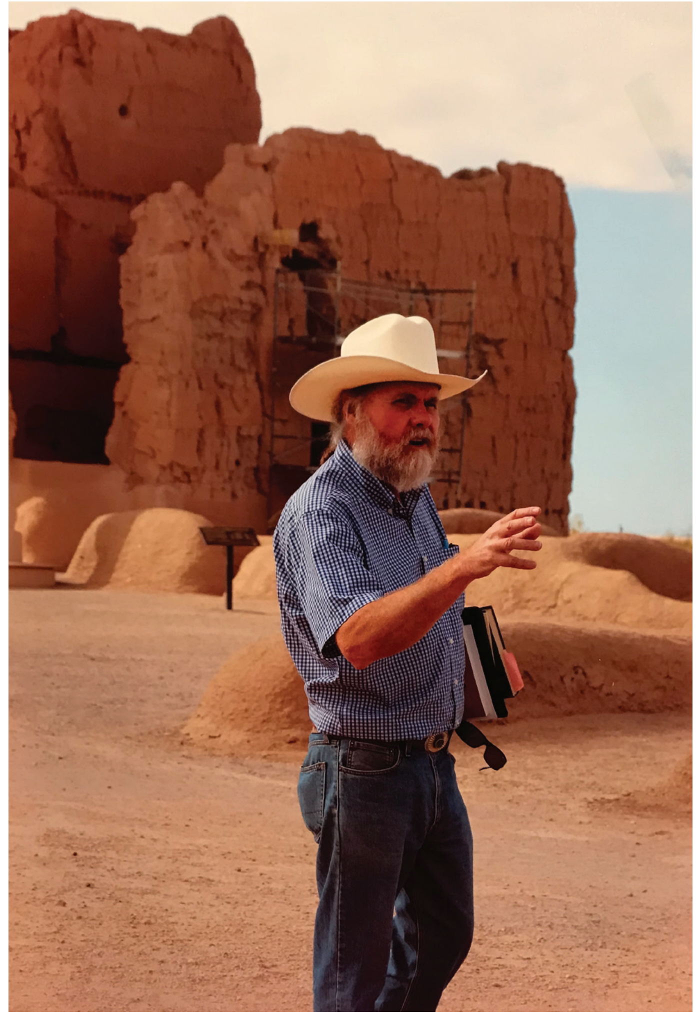
DOUGLAS B. CRAIG
(1956–2020)



His many friends and colleagues will greatly miss Douglas B. Craig, who passed away on May 14 at the age of 64 after an extended illness complicated by COVID-19. Doug and his wife Rebecca Craig shared their unique, artisan-built home in the desert near Marana, Arizona throughout their 34 years of marriage. Their life together was full of good food, good music, artwork, and dogs!

Doug came to Tucson and Hohokam archaeology following a 1978 Harvard University B.A., received a 1982 Anthropology M.A. from the University of Arizona, and later returned to complete his PhD in 2004. Doug was Staff Archaeologist at Pima Community College's Centre for Archaeological Field Training in the early 1980s and thereafter was Project Director for Desert Archaeology on the Roosevelt Community Development Study. Joining Northland Research, Inc. in 1993, he served as Project Director and Principal Investigator for the rest of his notably productive career.

Doug was the consummate field archaeologist, with expertise in the Phoenix, Tonto, and Tucson basins and surrounding areas. He had the foresight and on-the-ground skills to design, execute, and bring to full publication a series of projects that advanced central Hohokam issues and cutting edge approaches in regional archaeology. Investigations at the Grewe site near Casa Grande Ruins provided the basis for Doug's dissertation and combined many of the innovative intellectual pathways he so successfully pursued. These interests included the role of architectural visibility in population estimates, households and community development, duration of courtyard groups, Gila River stream flow in relation to population dynamics, agent based modeling, and Hohokam applications of house society concepts. His creative inquiries into the rise of Hohokam inequality addressed labor estimates for public architecture, prominent courtyard groups' sponsorship of feasting and ballcourt affairs, differential investments in domestic architecture, and the formation of corporate descent groups, property, and wealth.

In addition to his exemplary CRM publications, Doug was a prolific academic author and valued collaborator. His individual and co-authored contributions have appeared in Archaeology, American Antiquity, Journal of Field Archaeology, The Kiva, Journal of Arizona Archaeology, Archaeology Southwest, Oxford Handbook of Southwest Archaeology, and numerous chapters in thematic edited volumes from academic presses.

Doug generously supported archaeological organizations and public outreach. He served as preservation advocate and as President of Friends of Casa Grande Ruins National Monument, President of the Arizona Archaeological Council and co-guest editor of two initial issues of its Journal of Arizona Archaeology, on the Editorial Board of American Archaeology Magazine, in officer and editor positions for Old Pueblo Archaeology, and on the Marana Cultural Preservation Board. Audiences enthusiastically responded to Doug's lively presentations in countless public talks, site visits, and tours.

Suzy Fish will remember her experience as Doug's doctoral advisor when she gained a lasting colleague along with new perspectives on Hohokam archaeology. In a final collaboration at University Indian Ruin, we admiringly recall how field school students eagerly responded to Doug as pied piper, drawing them into the intellectual intricacies and adventure of investigating platform mounds.

Maren Hopkins will remember Doug as a loyal friend, mentor, and colleague who taught her how to be bold, stick to her guns, and own her ideas. Doug was a timeless person, full of energy, joy, and curiosity. His integrity, creativity, and intelligence will never be forgotten.

Suzanne K. Fish
Maren Hopkins

SANDALS AND THE BASKETMAKER OCCUPATION AT ANTELOPE CAVE, ARIZONA

Keith L Johnson

Antelope Cave, located in northwestern Arizona, is a major Virgin Branch secondary habitation site. Basketmaker II and III families resided here sporadically for nearly 500 years. Diagnostic Basketmaker sandals along with other material remains reveal a prehistoric lifestyle sustained by harvesting domesticated and wild plants along with hunting jackrabbits and cottontails. Sandals include Plain Weave Wickerwork, and Cordage (twined) types. Additionally, they provide direct radiocarbon dates and also help resolve issues of human sex and age demographics at the cave. The Basketmaker change over time from Z to S twist sandal cordage also is recognized and discussed. Potential new Basketmaker traits are suggested in the categories of sandals, dart points, and ritual.

Antelope Cave is a sunken limestone cavern (Figure 1) on the Arizona Strip in the northwestern corner of the Grand Canyon state (Figure 2). Ancestral Puebloans lived in the cave intermittently for 1,000 years, from late Basketmaker II into early Pueblo II times. Although habitation at the site was most intense during Pueblo I (Johnson and Pendergast 1960:4), my emphasis here is on the earlier Basketmaker II (40 BC–AD 400) and Basketmaker III (AD 400–600) occupations.

In addition to Antelope Cave, other important sites containing Basketmaker components have been investigated on the Arizona Strip (Figure 3). These include Heaton Cave (Judd 1926), Rock Canyon Shelter (Janetski 2017), several sites near Colorado City (Berg et al. 2003; Nielsen 1998), the Tuna Creek Site (Jones 1986), and Tuweep Valley (Thompson and Thompson 1974). Although not technically on the Arizona Strip, sites at Jackson Flat Reservoir (Roberts 2018) near Kanab, Utah, are added to this list because they represent Virgin Anasazi Branch habitations. All of these localities yielded some diagnostic Basketmaker objects (Fairley 1989:107–118; Lyneis 1995:208–211; for expanded discussion see Geib and Spurr 2000; Matson 1991:13–124, 2006). The dry caves and rockshelters typically contain perishable square-toe fiber sandals, human hair cordage, wooden atlatls and darts, bows and arrows, S-curved sticks, and cultivated maize and squash. Open sites are characterized by circular semisubterranean pit houses, storage cists (some stone lined or bell shaped), diagnostic stone dart and arrow projectile points, basin milling stones, one-hand cobble manos, ceramics, maize, and squash.

Nine of these diagnostic traits were identified in the Basketmaker midden at Antelope Cave. Absent were S-curved sticks, wooden bows, human hair cordage, ceramics, pit houses, storage cists and stone arrow points. The goals of this paper are to describe the Basketmaker materials recovered by University of California, Los Angeles (UCLA) archaeologists at Antelope Cave between 1956 and 1959 and to place these objects chronologically and culturally into the broader contexts of the Virgin Anasazi Region (Lyneis 1995) and general Southwestern prehistory.

All Antelope Cave archaeological specimens excavated or obtained by UCLA are permanently curated in the Fowler Museum of Cultural History on the campus of UCLA. Specimens recovered in 1956 and 1957 were given accession number 153, and objects recovered in 1959 and 1960 have been catalogued under accession number 244.

ANTELOPE CAVE AND VICINITY

Located on the Arizona Strip about 25 miles southeast of the City of St. George, Utah (see Figure 2), Antelope Cave is a large underground chamber 170 feet north–south by 70 feet east–west (Figure 4). The surface interior of the cave exhibits huge, heavy chunks of limestone fallen from the ceiling. The tons of jumbled rockfall cover most of the eastern half of the cave while the available cultural deposit makes up the western half (Figure 5). At the north end of the cave is a natural secondary sink hole enclosed by sloping layers of limestone slabs. The bottom of this pit is dark and about 75 feet below the entrance to the cave. Cultural deposits within the cave are badly marred by more than 80 years of intermittent looting that occurred both before and after limited archaeological excavations there in the 1950s and 1980s (Fisher et al. 2013:143–146; Janetski et al. 2013:4–6).

Keith L Johnson / Department of Anthropology, California State University, Chico, CA, USA / kljohnson@csuchico.edu

FIGURE 1. Entrance to Antelope Cave on July 28, 2008. View NE toward flat-topped Lost Spring Mountain rising 1,000 ft. above the gentle rolling plain of the Uinkaret Plateau. Left to right: Kyle Voyles (BLM) and Chris Johnson.

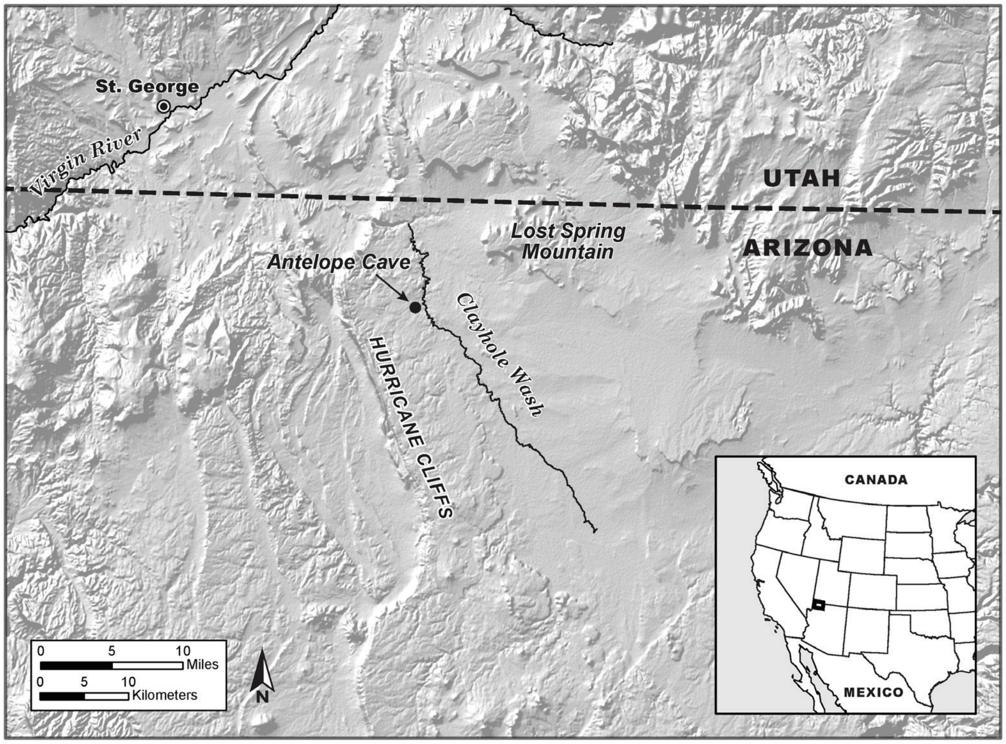


FIGURE 2. Location of Antelope Cave in northwestern Arizona.

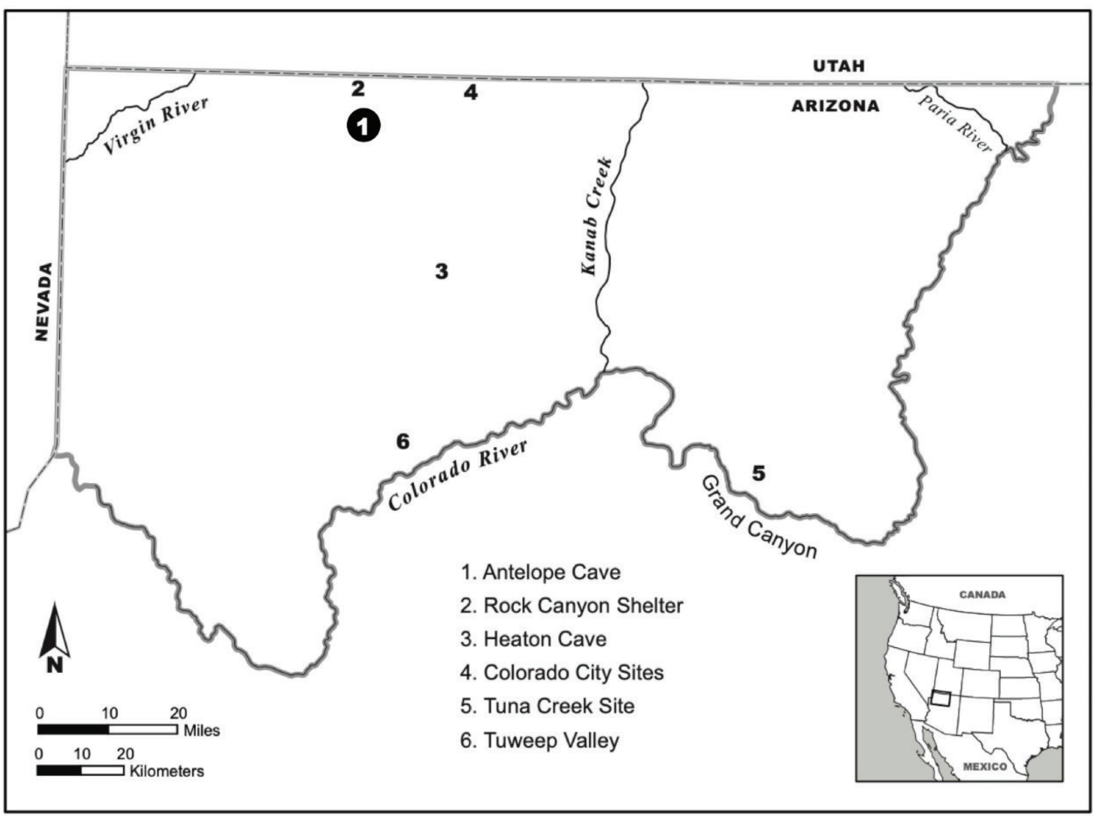


FIGURE 3. Important Basketmaker sites on the Arizona Strip.

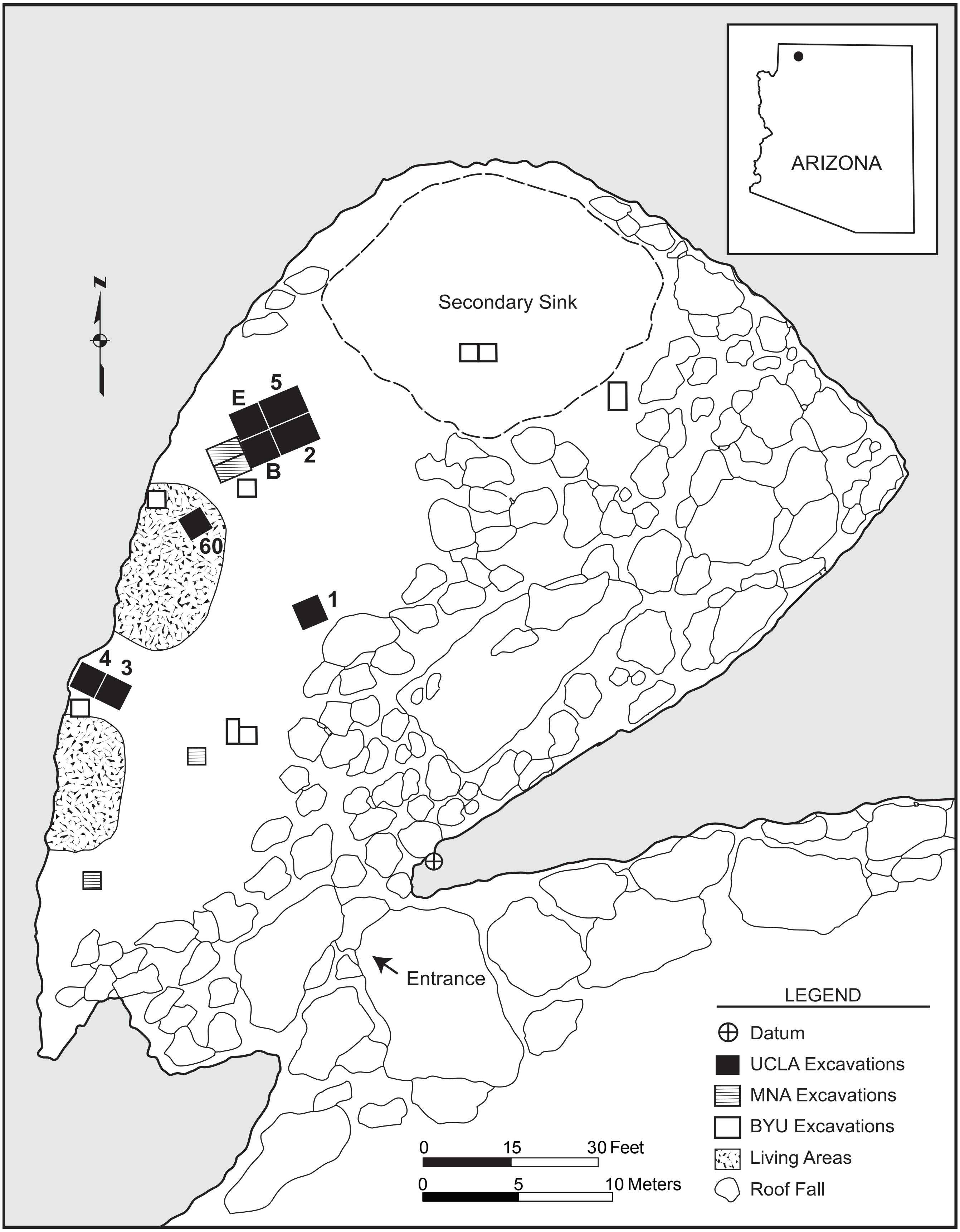


FIGURE 4. Map of the interior of Antelope Cave showing the location of units excavated by UCLA, Museum of Northern Arizona, and Brigham Young University.

FIGURE 5. View of the midden deposit in Antelope Cave showing the secondary sink (top) at the north end of the site and unit AC59-3 (left) under excavation at the southwest edge of the site.

The semi-arid terrain surrounding Antelope Cave is composed of low rolling hills that are cut by Clayhole Wash, an ephemeral stream, located 1,000 yards (914 m) east of the site (see Figure 2). Vegetation in the area is sparse but varied and is dominated by native plants of the Great Basin Desert shrub community. In April 1960, Dr. Richard Logan of the UCLA Geography Department identified 21 different plants within a 100-yard radius of Antelope Cave. Still common today are sagebrush (*Artemesia* sp.), Mormon tea (*Ephedra viridis*), snakeweed (*Gutierrezia* sp.), rabbitbrush (*Chrysothamus* sp.), and barberry shrub (*Berberis* sp.). Yucca (*Yucca* sp.) and pricklypear (*Opuntia* sp.), which were of primary importance to the site's prehistoric inhabitants, are very rare in the vicinity of the cave today. Also, juniper (*Juniperus osteosperma*), once more common and culturally significant to the Ancestral Puebloans, is represented now by one lone tree, 12 feet high, growing about 1 mile southwest of the site.

Significant fauna in the area today include cattle (*Bos taurus*), mule deer (*Odocoileus hemionus*), pronghorn (*Antilocapra americanus*), mountain sheep (*Ovis canadensis*), bobcat (*Felis rufus*), fox (Canidae), and the ubiquitous jackrabbits (*Lepus* sp.) and cottontails (*Sylvilagus* sp.) (see Hoffmeister 1986). With the exception of domestic cattle, the hunted remains of all these animals were recovered from the midden deposits in the cave (Fisher et al. 2013:149, 151).

Water in sufficient quantities to sustain Antelope Cave's occupants has concerned scholars who suggest a few springs several miles distant from the cave were the only reliable fresh water sources prehistorically available (Fisher et al. 2013:141; Fisher and Johnson 2014:309, Figure 1; Janetski et al. 2013:7, Figure 1.1). However, other researchers working on the Arizona Strip have underscored the importance of natural holes (water pockets) filled with rain that provided crucial drinking and culinary water to prehistoric settlements not close to permanent streams, springs or seeps (Dellenbaugh 1908:186–209, 245–254; Fairley 1989:145; Judd 1926:132; Thompson 1970:14, 39). In the Kayenta region east of the Arizona Strip, Geib (2011:55) refers to prehistorically important water pockets as plunge pools and weathering basins.

A closer look at Clayhole Wash (see Figure 2) and its potential significance to the Antelope Cave Puebloans is warranted. Clayhole Wash is 45 miles long and, when carrying water, flows south to north eventually emptying into Short Creek near the Arizona–Utah border. After about 30 miles from its start, the wash passes close to the archaeological site and, of course, periodic rainfall flowing along this long stretch would have delivered needed fresh water to the occupants of Antelope Cave. In addition, several small water pockets were found recently in Clayhole Wash just 1,063 yards (972 m) southeast of the cave (Figure 6). Natural depressions had formed in an area of limestone bedrock exposed in the normally dry sandy streambed. The discovery was made on July 15, 2014, and the holes in the bedrock contained a good amount of water even though the last rain fell nine days earlier. In fact, the largest pond had existed for at least four to six weeks as it contained wiggling polliwogs who were that old! It appears, therefore, that Antelope Cave's Puebloans obtained fresh water in two ways close to home without having to travel to distant springs, which would necessarily be a last choice.

BASKETMAKER EXCAVATION

Archaeologists from three institutions (see Figure 4; UCLA, Museum of Northern Arizona [MNA] and Brigham Young University [BYU]) have excavated the soft, dry prehistoric midden in Antelope Cave (see Fisher et al. 2013:143 and Janetski et al. 2013:4–6 for brief reviews). Square-toe sandals denoting the presence of Basketmaker II people have been recovered from several places in the cave. However, only one area has been defined as distinctly Basketmaker (Johnson and Pendergast 1960:3, 4). This area is confined to adjoining excavation units AC59-3 and AC59-4 (shown as units 3 and 4 in Figure 4) beginning about 18 inches below the surface of these units and extending to the bottom of the midden deposit between 42 and 48 inches from the surface of the site (English units were used during the UCLA excavations so are retained when referring to depths rather than converting to metric). The cultural materials above 18 inches in these two pits are attributed to the Pueblo I occupation which is heavily evident in all other areas of the cave. No Archaic period objects were encountered by UCLA archaeologists.

The two Basketmaker excavation units are located close to the west wall of the cave in a mounded toss zone adjacent to, and directly north of, a relatively level space tentatively identified as a living or habitation area (see Figure 4). BYU archaeologists placed a test unit (83-1) abutting this flat space and encountered only several centimeters of "spoil dirt" on top of sterile white limestone (Janetski et al. 2013:15).

UCLA units AC59-3 and 4 measured 5 ft. × 5 ft. and 4 ft. × 5 ft., respectively, and were excavated with trowels in 6-inch levels. All excavated midden was passed through nested ½-inch mesh and ¼-inch mesh screens located outside the cave (Figure 7; also see Adams et al. 2015:312, 313).

Stratigraphically, the two adjacent Basketmaker excavation units were characterized by four distinct sediment layers or lenses as well as a few scattered rocks (Figure 8). Deposits identified as midden contained artifacts and other cultural materials and appeared in shades of brown, olive green, grey, or black. Some midden lenses were obviously mixed with sticks and other vegetal matter. Midden mixed with white lime formed a third layer category. Areas of culturally sterile white lime powder represent the final recognizable layer type in the two excavation units. A looter's pit disturbed most of the surface of the two adjacent Basketmaker excavation units.

No features were recorded nor were human or animal interments encountered in units AC59-3 and 4.

RADIOCARBON DATING

Fourteen ^{14}C dates have been previously reported for Antelope Cave (Fisher et al. 2013:147, Yoder 2013:120). They, along with diagnostic artifacts, establish intermittent use of the cave from late Archaic times into the early Pueblo II period, 2000 BC–AD 1032. Five of the 14 dates are from plain weave pointed-/rounded-toe sandals that were worn between AD 680 and 1019, Pueblo I and II (Yoder 2013:119, 120).

Five new radiocarbon dates on Antelope Cave Basketmaker sandals are presented in Table 1. Of the sandals sampled, three are from the designated Basketmaker area, one from excavation unit E and one is without provenience. Dates range from 40 BC to AD 542, Basketmaker II and III. A conservative estimate, based on the above five assays, indicates Basketmaker people lived at the cave intermittently for about 500 years. None of the previously reported ^{14}C dates fall within or overlap this 500-year period.

ARTIFACT ANALYSIS

Although thousands of prehistoric objects were recovered during the UCLA excavations at Antelope Cave, relatively few were found in the Basketmaker area. This reflects the fact that the cave was not intensively occupied until Pueblo I times (AD 700–900). The following pages focus on the sandals (Tables 2 and 3) from Antelope Cave and then briefly address other cultural materials obtained from the Basketmaker excavations.

FIGURE 6. Water pocket in Clayhole Wash just southeast of the cave.

FIGURE 7. UCLA archaeologist Nick Katem operating a gasoline-driven power screen to sift midden just outside of the cave entrance (1959).

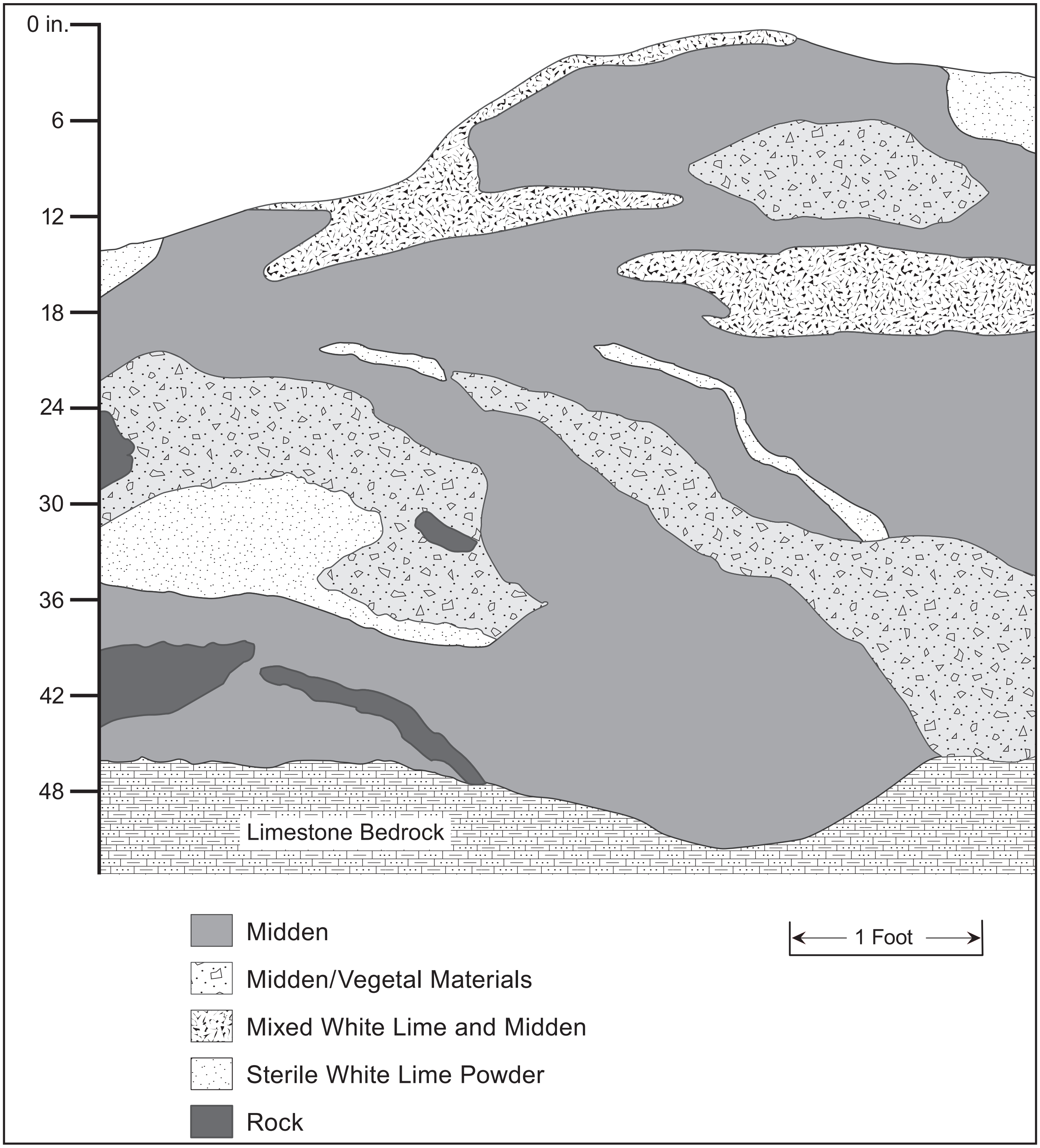


FIGURE 8. Profile of the west wall of AC59-3. Note looter's depression top left.

Table 1. Radiocarbon Dates on Fibers from Basketmaker Sandals at Antelope Cave

Lab No.	Sandal Cat. No.	Radiocarbon Age (BP)	$\delta^{13}C$	2σ Calibrated Age*
Beta 501579	244–289	1590 ± 30	-14.2 ‰	AD 406–542
Beta 496433	153–205	1880 ± 30	-20.1 ‰	AD 66–222
Beta 506809	244–2460	1890 ± 30	-18.8 ‰	AD 56–217
Beta 518312	244–2108	1920 ± 30	-16.0 ‰	AD 3–138
Beta 494823	244–2516	1960 ± 30	-9.6 ‰	40 BC–AD 87

*calibration database INTCAL13

Table 2. Provenience and Characteristics of Pueblo I Style Sandals in the UCLA Antelope Cave Collection

Cat. No.	Unit	Depth (in.)	Length (cm)	Width (cm)	Warps	Wear
153-29	E	18–30	–	–	4	H
153-30	E	18–30	27.0	11.5	4	H
153-57	NP	–	30.2	12.7	6	H
153-98	E	42–48	(missing)			
153-101	E	42–48	27.5	11.8	4	H
153-190	E	0–18	–	–	4	H
153-191	E	0–18	–	10.7	4	H
153-192	E	0–18	–	12.5	4	H
153-193	E	0–18	–	11.1	4	H
153-194	E	0–18	–	–	4	H
153-195	E	0–18	–	–	4	H
153-196	E	0–18	(missing)			
153-197	E	0–18	–	–	–	H
153-198	E	0–18	31.7	11.8	4	H
153-207	E	18–30	15.0 (in.)	5.9	6	H
153-208	E	18–30	28.8	12.1	4	H
153-210	B	36–42	24.0	10.8	4	H
153-211	B	36–42	25.3	–	4	H
153-212	B	12–24	32.0	12.2	4	H
153-213	B	24–36	28.8	12.5	4	H
153-214	B	24–36	–	11.2	4	H
153-215	B	24–36	29.9	11.6	4	H
153-238	B	0–12	–	–	4	H
153-312	NP	–	29.4	11.2	4	H

continued

Table 2. Provenience and Characteristics of Pueblo I Style Sandals in the UCLA Antelope Cave Collection

Cat. No.	Unit	Depth (in.)	Length (cm)	Width (cm)	Warps	Wear
153-313	NP	–	29.5	11.3	4	H
153-314	NP	–	30.3	11.6	4	H
153-315	NP	–	30.8	13.5	4	H
153-316	NP	–	29.5	11.4	4	H
153-317	NP	–	–	–	–	H
153-318	NP	–	–	–	4	H
153-319	NP	–	–	–	4	H
244-X	NP	–	–	–	4	M
244-X	NP	–	30.4	11.5	6	M
244-X	NP	–	29.5	11.1	6	M
244-X	NP	–	22.9	9.5	4	H
244-X	NP	–	26.6	9.4	4	M
244-X	NP	–	30.3	12.4	4	H
244-X	NP	–	–	11.3	4	H
244-X	NP	–	25.5	10.3	4	H
244-56	NP	–	–	–	4	M
244-57	NP	–	–	–	–	H
244-58	NP	–	–	–	–	M
244-59	NP	–	–	11.0	4	H
244-403	59-1	0–6	–	–	4	H
244-404	59-1	0–6	–	–	4	H
244-405	59-1	0–6	–	–	4	H
244-474	59-1	6–12	–	13.1	4	H
244-515	59-1	12–18	–	–	4	H
244-516	59-1	12–18	22.4	11.0	4	H
244-613	59-1	30–36	–	–	–	–
244-646	59-2	0–6	(missing frag)			
244-895	59-2	6–12	(missing frag)			
244-953	59-2	6–12	(missing frag)			
244-1194	59-2	18–24	30.7	11.4	6	H
244-1195	59-2	18–24	25.2	9.4	6	M

continued

Table 2. Provenience and Characteristics of Pueblo I Style Sandals in the UCLA Antelope Cave Collection

Cat. No.	Unit	Depth (in.)	Length (cm)	Width (cm)	Warps	Wear
244-1418	59-2	24–30	–	–	4	H
244-1419	59-2	24–30	–	–	–	H
244-1420	59-2	24–30	22.5	8.5	4	M
244-1586	59-2	31	25.6	11.1	4	H
244-1587	59-2	34	29.5	13.3	4	M
244-1588	59-2	35	28.1	11.9	4	H
244-1589	59-2	36	27.8	11.7	4	M
244-1769	59-2	41	26.5	13.6	6	H
244-1770	59-2	42	24.7	10.2	4	H
244-1775	59-2	36–42	–	–	–	–
244-1776	59-2	36–42	–	–	–	–
244-1792	59-2	46	–	–	4	H
244-1793	59-2	46	29.3	12.6	4	M
244-1794	59-2	45	30.1	13.4	4	M
244-1795	59-2	45	(missing)			
244-1796	59-2	42–48	–	–	–	–
244-2016	59-3	6	–	9.5	4	H
244-2025	59-3	3	–	–	–	–
244-2236	59-4	6–12	–	–	4	H
244-2303	59-4	16	26.7	–	4	H
244-2304	59-4	18	–	–	–	–
244-2750	59-5	12	26.2	10.1	4	H
244-2751	59-5	7	29.3	12.9	4	H
244-2973	59-5	12–18	(missing)			
244-3420	59-5	21	30.0	12.1	4	H
244-3609	59-5	24	27.4	12.8	6	H
244-4062	59-5	36	–	–	4	H
244-4063	59-5	30–36	–	–	4	H
244-4064	59-5	30–36	–	–	–	–
244-4065	59-5	30–36	–	–	4	H
244-4066	59-5	30–36	25.7	11.3	4	H
244-4444	59-5	38	26.1	11.2	4	H

continued

Table 2. Provenience and Characteristics of Pueblo I Style Sandals in the UCLA Antelope Cave Collection

Cat. No.	Unit	Depth (in.)	Length (cm)	Width (cm)	Warps	Wear
244-4445	59-5	40	31.1	11.1	4	H
244-4733	59-5	42–48	(missing)			
244-4763	59-5	48–54	–	–	4	H
244-4764	59-5	48–54	–	–	–	–
244-4793	59-5	42–48	(missing)			
244-4823	59-5	60–66	22.5	12.0	4	H
244-4863a	59-5	36–42	25.0	10.3	4	H
244-4863b	59-5	36–42	27.8	10.4	4	H
244-4863c	59-5	36–42	24.3	10.7	4	M
244-4883a	59-5	42–48	32.2	13.0	4	H
244-4883b	59-5	42–48	32.1	12.6	6	H
244-4904	NP	–	–	–	4	H
244-4930	60	–	30.0	12.1	4	H

NP = no provenience; H = high wear; M = moderate wear

Table 3. Provenience and Characteristics of Basketmaker Sandals UCLA Antelope Cave Collection

Cat. No.	Unit	Depth (in.)	Length (cm)	Width (cm)	Warps	Wear
153–100	E	42–48	–	–	–	H
153–205	E	30–42	25.5	12.6	8	H
153–310	NP	–	23.7	9.6	20	H
153–311	NP	–	25.5	–	12	H
244–289	NP	–	–	–	28	H
244–2108	59-3	18	26.5	11.0	22	H
244–2367	59-4	22	19.7	9.9	24	H
244–2430	59-4	30	23.5	10.5	22	H
244–2459	59-4	36	22.0	10.8	2	H
244–2460	59-4	36	23.4	11.4	22	H
244–2461	59-4	31	24.2	11.3	22	H
244–2462	59-4	34	24.4	10.5	24	H
244–2516	59-4	38	26.5	11.3	2	M
244–2974	59–5	12–18	–	–	–	H
244–3608	59–5	24–30	–	–	–	H

Age, Sex, and Storage of Sandals at Antelope Cave

This section explains the demographics of the cave's occupants based on the length measurements of sandals recovered at the site. Both Pueblo I and Basketmaker sandals are included in the analysis. The amount of wear on these sandals and their distribution in the cave also contribute to discussions of artifact caching and ritual use.

Pueblo I plain-weave sandals from Antelope Cave are typically made of yucca fiber, have pointed or rounded toes and four or six warps (Figure 9). All are from Pueblo I and II midden deposits in the cave. Yoder (2010; 2013:103–120, Appendix D and, E) thoroughly analyzed 75 Pueblo I style sandals from the MNA and BYU excavations at Antelope Cave.

UCLA investigations yielded 100 Pueblo I style sandals (see Figure 9). Of these, 46 are complete specimens, and 22 of the 100 lack provenience. Nine of the pointed-/rounded-toe sandals were gifted to the UCLA Antelope Cave collection: eight from Vilate Hardy of La Verkin, Utah, and one from Dr. Robert Euler when he was at Arizona State College. In all respects, the UCLA pointed-/rounded-toe sandals do not differ significantly from those so ably described by Dr. David Yoder.

Table 2 presents basic data on each of the UCLA Pueblo I style sandals. For complete specimens, lengths range from 22.4 cm to 32.2 cm (mean 27.9 cm); widths from 8.5 cm to 13.6 cm (mean 11.5 cm).

Specimen 153-207 (Figure 10) is the only small child's sandal known from Antelope Cave. It is Pueblo I style, has six warps, and likely a pointed or round toe. Because its heel and toe are broken off, its true length beyond 15.0 cm could not be determined. It is 5.9 cm wide. If the estimated original length of the sandal was around 17.5 cm, then its wearer was between 4 and 7 years of age based on Walter Taylor's analysis of Coahuila sandals (2003:71). This small sandal was the first irrefutable indication that family groups resided at the cave.

Age and Sex Determination

Because archaeological sandals are rarely found with feet attached, it is not possible to accurately determine whether foot length and sandal length are equal or how much shorter feet are than the sandals they stand on (see Taylor 2003). As a result the following discussion treats the length of each sandal to be about equal to the length of the foot that wore it and vice versa.

Based on sandal lengths which ranged from 20.5 cm to 32 cm, Yoder (2010:332–334, 342; 2013:111) attributed all the measurable Pueblo I sandals in his sample to adults, and Billinger and Ives (2015:85) concluded that those sandals indicated the paramount importance of adults (likely males) at Antelope Cave. The analysis of the UCLA Pueblo I style complete sandals (n=46) suggests a more balanced view of the age and gender composition of the cave's inhabitants (Table 4). In addition to the child's sandal described above, four UCLA sandals are less than 24.0 cm long and were likely worn by adolescents (10–18 years) and small adult females (Taylor 2003:71). According to Taylor's calculations, 20 UCLA sandals measuring between 24.0 cm and 28.5 cm long belonged to adults, both male and female, while the 24 large UCLA sandals measuring more than 28.5 cm in length fit the feet of adult men. Taylor's age estimates are based on data showing sandals are usually larger than the feet that wear them (2003:69). There is a bit of archaeological support for this. Guernsey (1931:Pl. 47g) illustrates a foot significantly shorter than its attached Basketmaker sandal.

Results similar to those using Taylor's calculations were obtained by employing the findings of Anderson et al. (1956:291, 292) on age and the average foot lengths of children (see Table 4). A necessary assumption is that Puebloan sandals and the feet that wore them were nearly of equal size. While this cannot be proven to be common, Kidder and Guernsey (1919:Pl. 69) illustrate an adult foot with an attached square-toe Basketmaker sandal the same length as the foot. In fact, the toes of the deceased extend to the very outside edge of the sandal's fringe! Based on Anderson et al. (1956:291), one UCLA Pueblo I sandal measuring approximately 17.5 cm long was worn by a 5-year old child. Three sandals between 22.4 cm and 22.5 cm long may have belonged to children 10 or 11 years old. The 10 sandals whose lengths measured between 24.0 cm and 26.1 cm fit male adolescents 13 to 18 years old and small adult females. The 35 remaining sandals, all over 26.1 cm long, belonged to adults, male and female.

Hrdlička's classic study of the feet of Pueblo groups in the Southwest (1935:438) was not particularly useful to the research here, as he measured only the feet of "healthy adult, or apparently full grown (complete dentition), subjects" (1935:245). However, his data do demonstrate the size range (5.7 cm) between the shortest male adult foot length (21.4 cm) and the longest (27.1 cm; average 24.3 cm) and the size range (4.5 cm) between the length of the smallest female adult foot (20.4 cm) and the largest (24.9 cm; average 22.2 cm).

Table 3 provides basic data on the Basketmaker sandals from UCLA's excavations. Eleven sandals have measurable lengths. Based on the age and gender estimates of Anderson et al. (1956) and Taylor (2003), one Basketmaker sandal was worn by an 8-year-old boy or girl (sandal length 19.7 cm), four sandals by 11–13 year old adolescent girls and boys (sandal length range, 22.0–23.7

FIGURE 9. Pueblo I style sandals from the UCLA Antelope Cave collection.

FIGURE 10. Child's Pueblo I sandal (upper face) from the UCLA Antelope Cave collection.

Table 4. Age and Gender Differences at Antelope Cave Derived from UCLA's Pueblo I Sandal Lengths

Number of Sandals	Sandal Length (cm)	Age and Gender
Based on Taylor (2003)		
1	17.5*	4–7 yrs, male or female child
4	22.4–23.9	10–18 yrs, adolescent males and small adult females
20	24.0–28.5	male and female adults
24	28.6–32.2	adult males
Based on Anderson et al. (1956)		
1	17.5*	5 yrs, male or female child
3	22.4–22.5	10–11 yrs, male and female children
10	24.0–26.1	13–17 yrs, adolescent males and small adult females
35	26.2–32.2	male and female adults

* estimated

cm), and four by adult males and females (sandal length range, 24.2–26.5 cm). The collection does not include any examples of large footwear for adult males.

In sum, this analysis of Pueblo I and Basketmaker style sandals confirms the clear likelihood that children, adolescents, and male and female adults lived and worked together at Antelope Cave. Citing the variety of cultural remains other than sandals found at the cave, Fisher et al. (2013:157) and Janetski et al. (2013:159) agree that family groups **often** (emphasis mine) resided at the site. The evidence suggests more often than not.

While family occupancy of Antelope Cave is beyond doubt, the ability to distinguish gender based on sandal evidence is elusive here and elsewhere. For example, at Antelope House, Magers (1986:254, Figure 84) did not address the issue and simply divided the population based on sandal lengths into immature and mature people. Likewise, Hays-Gilpin et al. (1998:123) concluded that sandal measurements cannot be used to distinguish adult female from adult male sandals for the Prayer Rock District in northeast Arizona. Accurate gender determinations are not possible because the ranges of adult male and female sandal measurements overlap.

Sandal Storage

For almost 30 years archaeologists have speculated that sandals may have been cached by Puebloan travelers to Antelope Cave for future use (Fisher et al. 2013:158; Janetski 2017:231; Janetski and Wilde 1989:17; Janetski et al. 2013:158;). This idea seems to be based primarily on the sheer abundance of sandals at the cave, with more than 175 recovered by scientific excavations alone. With so many, at least some of the sandals must have been cached for later use. However, there appears to be little hard evidence to sustain this view with a chief concern being the lack of identified storage pits at Antelope Cave. Caches of artifacts put away for future use, in the Great Basin and on the Colorado Plateau, commonly occur in some sort of pit or cist feature or within some style of container such as a bag or basket. No sandals at Antelope Cave occurred in storage features or containers. Sandals apparently were discarded in general refuse piles, not cached for reuse at another time. Amateur collector Vilate Hardy did report that she found some sandals under rocks in the Secondary Sink area, but the locations and circumstances of these finds are not confirmed and even so these items were just as likely to have been placed there by rodents as by humans.

From another angle, assuming that footgear with a good amount of wearable tread would most likely be stashed for future use, all the UCLA sandals were examined for wear on their soles (see Tables 2 and 3). Light wear (L) meant little or no abrasion; moderate wear (M) displayed considerable abrasion over much of the sole; heavy wear (H) was characterized by specimen fragmentation, the near obliteration of warp rows, and/or obvious depressions or holes worn through at the heel or toe end. Of the 98 sandal soles available for study, none were unworn or even lightly used, 14 showed moderate abrasion, and 84 were broken and/or had sustained heavy wear and would not be suitable for further use. The moderately abraded footwear might have been stored at the cave for reuse by a few Puebloan travelers. However, eight of these 14 sandals were recovered from the general midden deposit in excavated units and lacked any associations indicating they had been cached for some future purpose. The remaining six moderately worn sandals are of unknown provenience. In summary, it is clear that no indisputable archaeological evidence currently exists to support the conjecture that the Ancestral Puebloans intentionally cached sandals at Antelope Cave.

Although sandals were not purposely stored in the cave, their abundance (n=192) from all excavations raises the possibility that they were worn by pilgrims who visited Antelope Cave for ritual purposes and then discarded their used footwear in the cave before returning to their homes. Thus, Antelope Cave could have functioned primarily as a ceremonial locality similar to other Southwestern caves like Winchester Cave (Fulton 1941) in Arizona and Ceremonial Cave (Cosgrove 1947:34–37) in Texas. Over 1,200 sandals were found at the Texas site. This incredible number is attributed to Puebloan pilgrims visiting the shrine for ceremonies and leaving behind their worn sandals. In addition to sandals, Ceremonial Cave and Winchester Cave contained many types and quantities of ritual items and a paucity of utilitarian objects, all indicating the caves served ritual purposes and were not human habitation sites.

Antelope Cave, however, does not fit the archaeological footprint of prehistoric Southwestern shrines. Although it yielded plenty of sandals, very few possible ceremonial items were recovered: two stone flakes wrapped with fiber, several grass and stick impaled corncobs, and an animal skin rattle. Unlike at the shrines, thousands of plant and animal food remains came from the work at Antelope Cave. While some rituals may have taken place in the cave, the preponderance of evidence indicates that Antelope Cave primarily served as a secondary habitation site for Ancestral Puebloans as they harvested maize and netted leporids in the surrounding area.

Basketmaker Sandals

The UCLA Antelope Cave collection contains 15 Basketmaker sandals of which 10 are complete and five are fragments (Tables 3 and 5). Three sandals lack provenience, and of these, two were donated by Vilate Hardy. All of the specimens are made from yucca leaves, and they typically have square toes and heels. In 2018, the 15 Basketmaker sandals were sent to Dr. Laurie Webster for analysis (Webster 2018). Based upon construction variations, she sorted the Basketmaker sandals into four types: 2-Warp Plain Weave Wickerwork, Multiple-Warp Plain Weave Wickerwork, Square-Toe Cordage, and Scallop-Toe Cordage. Table 5 summarizes the results of her analysis.

2-Warp Plain Weave Wickerwork

There are two sandals (244–2459, 244–2516) in this category (Figures 11 and 12, see Table 5). They are made of crushed, untwisted yucca leaves and have square or slightly rounded toes and heels. Their weave structure is 1/1 weft-faced, plain weave worked in a Figure 8 motion, with construction beginning at the heel and ending at the toe. The warp element is folded into a U-shape at the heel and the two ends are tied together with a square knot at the toe end.

Sandal 244-2459 (see Figure 11) has a warp and weft of crushed, untwisted yucca leaves, and the warp is wrapped crosswise with yucca leaves at the heel. One complete z-twisted tie and one broken tie crisscross each other at the toe end and extend toward the heel where the unbroken tie is wrapped around a crosswise 2s-Z tie. The ends of the warps probably became the toe-heel ties.

In sandal 244-2516 (see Figure 12), the warps are crushed z-twisted yucca leaves, and the wefts are untwisted yucca leaves. The sandal's tie system is composed of a z-twisted yucca fiber strand (probably the extension of one warp) which has been lengthened by the addition of new strands, all joined together by two square knots. This long strand extends from the toe to the heel of the sandal, loops around the crosswise warp, and goes back to the toe thereby creating two parallel ties that appear to have formed a large oval.

Sandals similar to the 2-Warp Wickerwork ones from Antelope Cave have been found in northwestern Arizona at Bighorn Cave (Hovezak and Geib 2002:125–128); in southeastern Nevada at Black Dog Cave (Winslow and Blair 2003:317–319) and Etna Cave (Wheeler 1973:18–21); in southern Arizona at Ventana Cave (Haury 1950:433–435, Pl. 44d); in southwestern New Mexico at Bat Cave (Dick 1965:74, 75), Tularosa and Cordova Caves (Martin et al. 1952:232, 241, 259–262), Y Canyon Cave and O Block Cave (Martin et al. 1954:166, 167), and U-Bar, Buffalo and Pinnacle Caves (Lambert and Ambler 1961:57–62).

This 2-warp style is common at early Hohokam and Mogollon sites in the southern Southwest and late Archaic sites in the Great Basin but are notably rare at Basketmaker sites in the northern Southwest. During the later Pueblo period, a different, more rigid style of 2-warp wickerwork sandal became popular in southern Utah and northern Arizona (Kidder and Guernsey 1919:Pl. 38a, b), but was probably unrelated to the earlier style. At Antelope Cave, 2-warp sandals occur only in the designated Basketmaker deposit. Sandal 244-2516 has a radiocarbon date of 40 BC–AD 87 and is the oldest dated sandal in the UCLA collection.

Multiple-Warp Plain Weave Wickerwork

Three specimens (2 complete and 1 fragment) from Antelope Cave comprise this type in the UCLA collections (Figures 13 and 14, see Table 5). They are multiple-warp, 1/1 weft-faced, plain weave wickerwork sandals made

Table 5. Attributes of Basketmaker Sandals in the UCLA Antelope Cave Collection

Cat No.	Elements	Weave structure	Toe	Heel	Method of attachment	Raised tread arrangement	Additional comments
Two-Warp Plain-Weave Wickerwork Sandals							
244-2459	Crushed, untwisted yucca leaves	1/1 figure-8 weave. Warp folded into a U-shape at heel and the ends tied together at toe with square knot. Warp ends become toe-heel ties.	Slightly rounded	Slightly rounded	Two crisscross ties extend from toe to heel strap	N/A	Complete
244-2516	Crushed whole yucca leaves, z-twisted warp, untwisted weft	1/1 figure-8 weave. Warp folded into a U-shape at heel and the ends tied together at toe with square knot. Warp ends become toe-heel ties.	Square	Slightly rounded	Two parallel ties extend from toe to heel	N/A	Complete. Frayed wefts create padding on underside. AMS date: cal 40 BC–AD 87.
Multiple-Warp Plain-Weave Wickerwork Sandals							
153-100	Crushed whole yucca leaves, 2s-Z warp, S weft	Body: 1/1 weft-faced plain weave. Three warps and part of a fourth. Bolster toe: 360 degree self-selvage secured with S-wise 2-strand twining.	Square bolster toe with self-fringe	Missing	Toe loop, heel missing	N/A	Toe fragment
153-205	Crushed whole yucca leaves, 2s-Z warp, S weft	Body: 1/1 weft-faced plain weave. 8 warps. Bolster toe: 360 degree self-selvage secured with Z-wise 2-strand twining.	Square bolster toe with self-fringe	Square	Toe loop, heel strap	N/A	Very large, complete. AMS date: cal AD 66–222.
153-311	Crushed whole yucca leaves, 2z-S warp, S weft	Body: 1/1 weft-faced plain weave. 12 warps. Bolster toe: 360 degree self-selvage secured with Z-wise 2-strand twining.	Square bolster toe, remains of self-fringe.	Square	Toe loop, heel strap	N/A	Darned with yucca leaves at toe and heel.
Cordage Sandals							
153-310	Yucca fiber, 2z-S and 2s-Z warp, S weft	Body: 1/1 weft-faced plain weave alternating with 2-strand wrapped twining. Raised tread: 2-strand wrapped twining.	Square with braid-like finish	Square	Toe loop and heel strap (remnants)	Vertical columns; remnants of raised pad down center of sole	Large hole at heel.
244-289	Yucca fiber, 2z-S warp and weft	Toe: 2/1 twill over folded warps. Body: 1/1 weft-faced plain weave alternating with 2-strand twining. Raised tread: 2-strand wrapped twining.	Very slightly scalloped	Missing	Toe loop possibly replaced by side loops (remnants)	Diagonal pattern	Two Fragments. Transitional late BM II-early BM III style. AMS date: cal AD 406–542.
244-2108	Yucca fiber, 2z-S warp and weft	Body: 1/1 weft-faced plain weave alternating with 2-strand wrapped twining. Raised tread: 2-strand wrapped twining.	Square with braid-like finish	Square	Toe loop and heel strap	Vertical columns; remnants of raised pad down center of sole	Red pigment along both sides of heel. AMS date: cal. AD 3–138.

continued

Table 5. Attributes of Basketmaker Sandals in the UCLA Antelope Cave Collection

Cat No.	Elements	Weave structure	Toe	Heel	Method of attachment	Raised tread arrangement	Additional comments
244-2367	Yucca fiber, 2z-S warp and weft	Body: 1/1 weft-faced plain weave alternating with 2-strand wrapped twining. Raised tread: 2-strand wrapped twining.	Square with braid-like finish	Square	Toe loop and heel strap	Diagonal or grid pattern; remnants of raised pad down center of sole	Nearly complete. Hole at heel.
244-2430	Yucca fiber, 2z-S and 2s-Z warp, 2z-S weft	Body: 1/1 weft-faced plain weave alternating with 2-strand wrapped twining. Raised tread: 2-strand wrapped twining.	Square with braid-like finish	Square	Toe loop and heel strap	Vertical columns; remnants of raised pad down center of sole; extra cordage stitched into sole	Nearly complete.
244-2460	Yucca fiber, 2z-S warp and weft	Body: 1/1 weft-faced plain weave alternating with 2-strand wrapped twining. Raised tread: 2-strand wrapped twining.	Square with braid-like finish	Square	Toe loop and heel strap	Vertical columns; remnants of raised pad down center of sole; extra cordage stitched into sole	Nearly complete. Worn at heel. AMS date: cal AD 56–217.
244-2461	Yucca fiber, 2z-S warp and weft	Body: 1/1 weft-faced plain weave alternating with 2-strand wrapped twining. Raised tread: 2-strand wrapped twining.	Square with braid-like finish	Square	Toe loop and heel strap	Vertical columns; remnants of raised pad down center of sole; extra cordage stitched into sole.	Nearly complete. Worn at heel.
244-2462	Yucca fiber, 2z-S and 2s-Z warp, 2z-S weft	Body: 1/1 weft-faced plain weave alternating with 2-strand wrapped twining. Raised tread: 2-strand wrapped twining.	Square with braid-like finish	Square	Toe loop (remnant) replaced by side loops	Vertical columns; remnants of raised pad down center of sole; extra cordage stitched into sole	Nearly complete. Worn at heel. Intact side loops.
244-2974	Yucca fiber, 2z-S warp and weft	Body: 1/1 weft-faced plain weave at toe. Remainder of sandal missing.	Square with braid-like finish	Missing	Missing	None observed	Toe fragment.
244-3608	Yucca fiber, 2z-S warp and weft	Body: 1/1 weft-faced plain weave alternating with 2-strand wrapped twining. Raised tread: 2-strand wrapped twining.	Missing	Square	Missing	Diagonal pattern	Red pigment along edge.

FIGURE 11. Two-warp Plain Weave sandal (244-2459) of yucca leaf fibers, upper face. Photograph provided by Laurie Webster.

FIGURE 12. Two-warp Plain Weave sandal (244-2516) of yucca leaf fibers, upper face. Photograph provided by Laurie Webster.

FIGURE 13. 8-warp Wickerwork sandal (153-205) of crushed yucca leaves, upper face.

FIGURE 14. 12-warp Wickerwork sandal (153-311) of crushed yucca leaves, upper face.

of crushed yucca leaves and have square toes and heels. The warps consist of two crushed yucca leaves twisted together to create a 2s-Z warp in two sandals and a 2z-S warp in the other. The warp elements are folded into a U-shape at the heel and extend to the toe. The weft is composed of a single crushed yucca leaf twisted S-wise. The sandals have a fringed bolster toe with a 360˚ self-selvage secured with 2-strand twining. The bolster toes were made by alternately wrapping each warp element around a pair of crosswise 2-strand twining cords of single crushed yucca leaves. The twining elements are worked Z-wise in two sandals and S-wise in the other.

Sandal 153-100 is a toe fragment, which when whole, had more than four 2s-Z warps. A parallel row of 2-strand, S-twined crushed yucca leaves anchors the warp ends to the underside of the toe. The shredded warp ends extend out from the bolster toe as fringe. The sandal has an incomplete 2-strand 2z-S toe loop.

Sandal 153-205 (see Figure 13) is a large and complete 8-warp sandal with a frayed yucca leaf fringe along both side edges and at the upper end of the bolster toe (Figure 15). A parallel row of 2-strand Z-twined yucca cords anchors the warp ends to the underside of the toe. The warps are folded 180 degrees at the heel. Overhand knots along each side selvage indicate where new wefts were added. A 2-strand toe loop and 3-strand heel strap are made from yucca fiber.

Specimen 153-311 (see Figure 14) is a 12-warp sandal with an incomplete bolster toe. The heel was finished by wrapping the warp elements around and inserted between each other, leaving the frayed ends to become a short fringe on the underside of the heel. Weaving began at the heel and terminated at the toe. There is a broken 2s-Z yucca fiber toe loop and a 4-strand 2s-Z heel strap. The sandal is darned with yucca leaves at the toe and heel.

Multiple-Warp Plain Weave Wickerwork sandals generally resembling those reported here have been found in southeastern Nevada at Black Dog Cave (Winslow and Blair 2003:316, 320, 321); in northeastern Arizona at Betatakin (Judd 1930:64, Pl. 41), Painted Cave (Haury 1945:42, Pl. 17e, f), Cave 1 (Kidder and Guernsey 1919:158, Pl. 67b), Antelope House (Magers 1986:259, 260), and Cave 1, Cave 11, Obelisk Cave (Morris 1980:118, 120); in southeastern Arizona at Winchester Cave (Fulton 1941:31–33, Plate. Vlll); in southeastern Utah at Sand Dune Cave and Dust Devil Cave (Lindsay et al. 1968:92–94, 117, 118), and Desha 1 (Geib and Robins 2003); in southwestern Colorado at the Falls Creek North Shelter (Morris and Burgh 1954:65, Figures. 34, 99d); in southwestern New Mexico at Bat Cave (Dick 1965:74, 75), Kelly Cave (Cosgrove 1947:28, 90, 91, Figures. 91, 92), Tularosa and Cordova Caves (Martin et al. 1952:241, 263–266), and Y Canyon Cave (Martin et al. 1954:162, 166, 167). In addition, Kankainen (1995) describes Multiple-Warp Wickerwork sandals from four sites in Arizona and 10 sites in Utah. Apparently, published excavation reports are not available for these 14 sites.

Beyond the major features (i.e., multiplewarp, plain weave, weft faced, and square toe/heel) that define the type, it is important to remember that Multiple-Warp Wickerwork sandals have additional variable attributes not universally shared. For example, the bolster toes characteristic of all three sandals at Antelope Cave do not exist, as far as I can tell, on any other plain-weave wickerwork sandals from the Great Basin or the Southwest. They do, however, occur on some Basketmaker II plain-weave cordage sandals from northern Arizona and southeastern Utah (e.g., Osborne 2004:Figure 97).

Multiple-Warp Wickerwork sandals are more widely distributed and more abundant over much of the American Southwest than are the 2-warp sandals previously discussed. However, both sandal types are found in several time periods and occur in different archaeological cultures including Puebloan, Hohokam and Mogollon. According to Osborne (2004:125), the prehistoric residents of Mesa Verde never wore square-toe, multiple-warp, plain-weave sandals but favored plaited sandals instead.

Antelope Cave's three Basketmaker Multiple-Warp Wickerwork sandals were not recovered from the designated Basketmaker area (units AC59-3, 4). Two came from excavation unit E and one was donated by Vilate Hardy (see Table 3). Sandal 153-205 from unit E has a ^{14}C date range of cal AD 66–222 (see Table 1), probably making it somewhat younger than the cave's 2-Warp Wickerwork sandals.

Square-Toe Cordage

Square-Toe Cordage sandals are a classic Basketmaker II footwear. Often referred to as twined sandals in the literature, they are more accurately described as cordage sandals because most incorporate both plain weave and twining weave structures, dominated by the former. At Antelope Cave nine examples (153-310, 244-2108, 244-2367, 244-2430, 244-2460, 244-2461, 244-2462, 244-2974, 244-3608) of finely woven, multiple-warp, square-toe, square-heel yucca cordage sandals fit into this category (Figure 16, see Table 5). All have wefts of 2z-S yucca fiber cords, square toes with a braid-like finish, toe loops and/or heel straps, soles with raised treads arranged in vertical columns or diagonal patterns and raised ridges (the remains of pads) down the center of their soles. Six sandals have 2z-S yucca cordage warps and three sandals (153-310, 244-2430, 244-2462) have both 2z-S and 2s-Z warp elements. The number of warp rows per sandal varies from 20 to 24 (see Table 3).

FIGURE 15. Close-up of Wickerwork sandal 153-205 showing bolster toe, edge fringe, and 2-strand toe loop. Photograph provided by Laurie Webster.

FIGURE 16. Square Toe Cordage sandals, (left to right) 244-2460, 2461.

The weave structure appears to be 1/1 weft-faced plain weave alternating with 2 strand S twist wrapped twining. The weave is very tight on the sandals making it difficult, if not impossible, to identify and differentiate the rows. However, the twining rows on sandals 244-2460 and 244-3608 are separated by five or six rows of plain weave.

Toes were finished by a weft-wrapping technique resulting in a braid-like appearance (Figure 17). This was accomplished in a sequence of four steps (Webster 2018):

The warps were arranged parallel to each other and joined with a crosswise row of 2-strand twining (Z).

Each warp was folded over the twining cord and the two ends were brought back together, one in front, the other in back.

The back strand of each warp pair was then used as a wrapping element to encircle the front strand and the adjacent warp pair in 2/1 (over 2 warp pairs, back around 1 warp pair) weft-wrapping (Z).

The end of each wrapping element was trimmed off on the underside of the toe, leaving the front strand of each pair to serve as the sandal warp for the remainder of the sandal.

Similar braid-like toe finishes on square-toe cordage sandals from sites in Utah are illustrated by Kankainen (1995:90), Nusbaum (1922: Plate XXXVIII) and Osborne (2004: Figure 97 right), but it is not known if the toe finish construction on these sandals is the same as that just described for the Antelope Cave sandals. The heels of the Antelope Cave Square Toe Cordage sandals were finished by wrapping the warp elements around and between each other, leaving their frayed ends to extend as fringe on the underside of each heel.

The vertical columns of raised tread on the soles of six sandals (Figure 18) were created by vertically wrapping the twining wefts around each other to produce a series of raised protrusions (cf. Osborne 2004: Figure 67a–c), a technique known as wrapped twining (Adovasio 1977:16, 19, Figure 11). The wrapping occurs between pairs of warps and obscures the vertical line between the warp pairs.

Sandals 244-2367 and 244-3608 have raised treads displaying a diagonal or checkerboard pattern on their soles (Figure 19). The raised protrusions used to create these patterns were produced by the same twining technique described above.

Each complete sandal has a raised ridge down the center of its sole (Figure 20). The ridge appears to be the remains of a pad that originally extended the whole length of the sole. Most of the pad is worn away leaving only frayed warp and weft ends. Apparently, these wefts were partially inserted as short pieces of cordage near the middle of the row, leaving their two loose ends to protrude on the underside. Lindsay et al. (1968:91) describe similar central sole pads on cordage sandals from Sand Dune Cave in Utah. Sandals 244-2430, 244-2460, 244-2461, and 244-2462 also have extra cordage attached to their soles (Figure 21). These coarse 2s-Z or 2z-S yucca cords, possibly the ends of the toe loops and heel straps, were stitched through the sandals producing thick padding on the soles under the ball of the feet and at the heel. Most of this padding is now worn away.

Unique aspects of some of the UCLA cordage sandals include slightly raised twining rows on the lower surface of the 244-3608 heel fragment, the side loops and lacing made of 2s-Z yucca cords for sandal 244-2462 (see Figure 20), the single row of S-twining prominently running across the midsection of the upper surface of sandal 244-2367 (Figure 22), and an orange-red stain along the side edges of the heels of sandals 244-2108 and 244-3608. Dyed wefts to produce colored designs are not present on any Antelope Cave Square-Toe Cordage sandals.

Toe loops can be described for six sandals. Four specimens (244-2367, 244-2430, 244-2460, 244-2461) have 4 to 8-strand 2s-Z yucca cordage loops (see Figure 17). Sandal 244-2108 has a 4-strand 2s-Z toe loop that is bound crosswise with a yucca leaf strip. Sandal 244-2462 likewise has a 4-strand toe loop but it is composed of one strand of 2s-Z cordage and three strands of yucca leaf strips. Two more 2s-Z yucca cords, one tied in a square knot, are located below the toe loop.

Heel straps on four sandals (244-2367, 244-2430, 244-2461, 244-2462) were made of 4–12 strands of 2s-Z yucca fiber cords (see Figure 21). The heel strap on 244-2460 is composed of a 6-strand 2z-S cord with two broken strands repaired by a square knot. Sandal 244-2108 has a heel strap of four strands composed of two strands of 3 (2z-S) Z yucca cordage and two strands of a 3-strand braid of 2z-S yucca. The cordage and braid were folded back and forth to make the four strands.

Yoder (2013:119, 120) briefly reports on two additional Square-Toe Cordage sandals recovered from Antelope Cave. Their provenience inside the cave is not given. One was found by a crew from MNA in 1954 and the other, a fragment, by BYU archaeologists in 1983. The illustrated sandal is much like the UCLA Square-Toe Cordage examples and appears to have a braid-like toe finish and a raised worn out fiber ridge down the center of its sole.

Additional examples of Square-Toe Cordage sandals similar to those described here for Antelope Cave have been reported from northwestern Arizona at Rock Canyon Shelter (Janetski et al. 2013:134–136) and Heaton Cave (Judd 1926:148, 154, Pl. 57b); from southeastern Nevada at Black Dog Cave (Winslow and Blair 2003:308–315); from northeastern Arizona at

FIGURE 17. Close-up of sandal 244-2367 showing braid-like toe finish and 4 strand 2s-Z toe loop. Photograph provided by Laurie Webster.

FIGURE 18. Close-up of vertical columns of raised protrusions on the sole (heel end) of sandal 244-2460. Photograph provided by Laurie Webster.

FIGURE 19. Close-up of diagonal pattern of raised protrusions on the sole of sandal 244-2367. Photograph provided by Laurie Webster.

FIGURE 20. Sole of sandal 244-2462 showing 2s-Z side loops and the remains of a raised ridge down the center. Photograph provided by Laurie Webster.

FIGURE 21. Close-up of 244-2461 heel showing 11-strand 2s-Z heel strap, two rows of overcast stitching above the strap and yucca leaf wrapping darned through the sole. Photograph provided by Laurie Webster.

FIGURE 22. Upper face of 244-2367 displaying a prominent row of S-twining extending across the middle of the sandal. Photograph provided by Laurie Webster.

Sagi ot Sosi Canyon (Cummings 1910:14), the Kayenta and Chinle Districts (Guernsey 1931:66, 67, Pl. 29), the Prayer Rock District (Morris 1980:116, 117), Broken Roof Cave (Deegan 1996:27–44), Cave 1, and Sunflower Cave (Kidder and Guernsey 1919:159, 160, Pl. 68, 69); from southwestern Utah at Cave du Pont (Nusbaum 1922:73–80, Plate XXXVI–XXXIX); from southeastern Utah at Sand Dune Cave (Lindsay et al. 1968:90–92); from southwestern Colorado in Mesa Verde (Osborne 2004:89, 90); and from southwestern New Mexico at Tularosa Cave (Martin et al. 1952:277, 280–282). Kankainen (1995:33–196) illustrates seven square-toe–square heel cordage sandals, three from sites in Arizona, two from Utah, and two are from unknown localities. While Square-Toe Cordage sandals have been recovered from four southwestern states plus Nevada, they are concentrated in northeastern Arizona and southeastern Utah. Antelope Cave sandals are geographically on the far western periphery of the Basketmaker II universe of fiber cordage footgear. Their closest affinities appear to be with the Sand Dune Cave, Cave du Pont, and Black Dog Cave cordage sandals.

Naturally, the specific attributes of the square-toe–square-heel cordage sandals vary somewhat within and between sites and regions. For example, Deegan (1996) recognizes both fringe toe and bolster toe sandals from Arizona and Utah. In contrast, all Antelope Cave Square-Toe Cordage sandals have braid-like toe finishes. Some Basketmaker II cordage sandals have side loops, but most do not. Thus, because of the variety of recognizable attributes, it is often necessary to individually describe the sandals that belong to the same defined type, which in this case is Square-Toe Cordage.

Osborne (2004:89–91) describes cordage sandals that are intermediate in shape and construction between the square-toe Basketmaker II sandals and the later Basketmaker III scallop-toe footwear. These intermediate specimens evidence the slow evolution of Puebloan sandal making from one time period to the subsequent one. The twist direction of cordage warps is an example of the changes between square- toe sandals and scallop toe sandals. The warps on most Basketmaker II square-toe cordage sandals are characteristically 2s-Z while those on the following Basketmaker III scallop toe sandals are characteristically 2z-S or 3z-S. At Antelope Cave, all nine Basketmaker II Square-Toe Cordage sandals have 2z-S warps (and wefts). As noted earlier, sandals 153-310 and 244-2462 additionally contain 2s-Z warp elements. Warps on sandal 244-2430 are primarily 2s-Z with one or more being 2z-S. Thus, in accord with Osborne, it appears that the Antelope Cave Square-Toe Cordage sandals carry at least one prior-adopted Basketmaker III trait, 2z-S warps.

Six of UCLA's nine Square-Toe Cordage sandals were recovered from the Basketmaker II levels in units AC59-3 and 4. Another (153-310) was donated by Vilate Hardy and two fragments (244-2974 and 244-3608) were excavated from pit AC59-5. Sandal 244-2108 was found 18 inches below the surface of AC59-3, at the very top of the Basketmaker deposit, and dates between cal AD 3 and 138 (see Table 1). Sandal 244-2460 has a radiocarbon date range of cal AD 56–217. It and three of the other Square-Toe Cordage sandals were encountered in the 30–36-inch level of AC59-4.

Scallop Toe Cordage

Although scallop-toe sandals are more typical of the Basketmaker III period, the transition from the square-toe to a scalloped one began during late Basketmaker II. Only one example of a Scallop-Toe Cordage sandal (244-289) was found at Antelope Cave (Figure 23, see Table 5). It is comprised of two fragments with some charred edges. The sandal displays a very shallow scallop toe, which differs in construction from the square toe of the other cordage sandals just discussed. The sandal's 28 warps and its wefts are 2z-S yucca cordage, and the body is woven in 1/1 weft-faced plain weave alternating with rows of 2 strand S twining. There is part of a frayed toe loop and some frayed 2z-S wefts along the sandal's side edges suggest the former presence of side loops. Warp rows number 28 and are made of 2z-S yucca fiber cords.

The toe of the sandal was started by weaving a warp strand into a 3-cm-long band in a 2/1 twill pattern (Figure 24). This twill-woven strip was folded horizontally over a suspension cord, then the two ends of the warp were brought back together and woven as a pair for a few rows in 2-strand S twining, after which the lower strand of each warp pair was trimmed off. The remainder of the sandal was woven over single warps in 1/1 plain weave alternating periodically with 2-strand S twining. The sides of the sandal are 180˚ self-selvages. The sandal's heel is missing, so its shape, square or puckered, and means of finishing could not be determined.

The sole is covered by a raised tread that features a diagonal design at the toe and heel separated by a 4-cm-wide band of horizontal lines (Figure 25). The raised tread was produced by wrapping one of the twining wefts vertically around the other to create a series of raised protrusions. There appear to be one or two vertical wraps between the warps.

Scallop-Toe Cordage sandals, more finely woven than the Antelope Cave one, are known from northeastern Arizona at Sagi ot Sosi Canyon (Cummings 1910:10, 11), Cave 1, Segi (Guernsey 1931:28, 77, Pl. 9, 47), five sites in the Prayer Rock District (Hays-Gilpin et al. 1998:42–44, 51–61; Morris 1980:116–118); from southwestern Colorado at Mesa Verde (Osborne

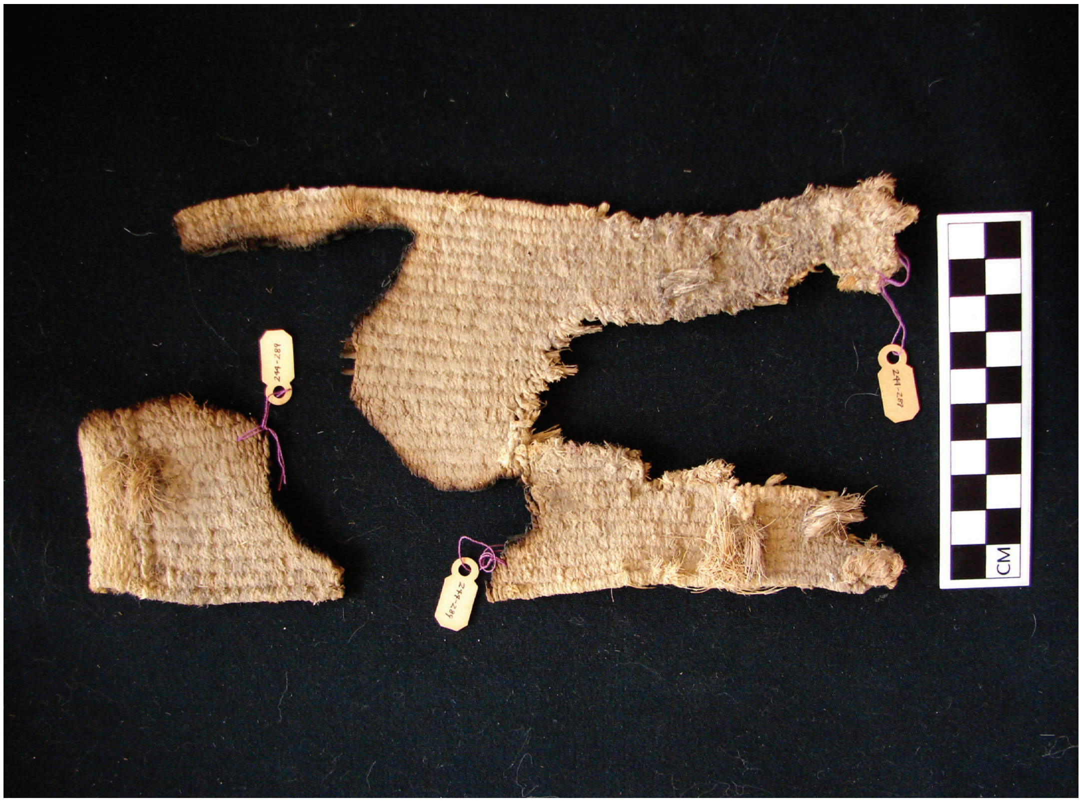


FIGURE 23. Scallop Toe Cordage sandal (244-289), upper face. Photograph provided by Laurie Webster.

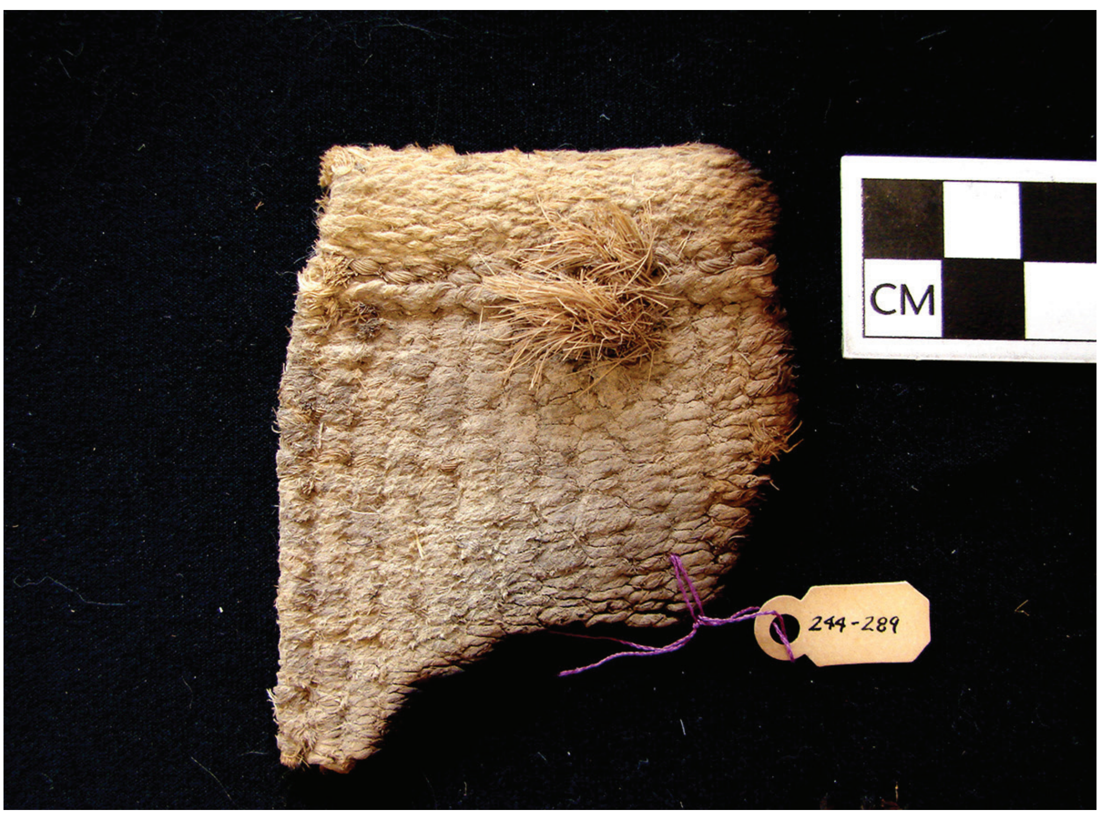


FIGURE 24. Close-up of upper face of sandal 244-289 toe showing 2/1 twill weave toe finish and suspension channel (arrow). Photograph provided by Laurie Webster.

FIGURE 25. Sole of Scallop Toe Cordage sandal 244-289 exhibiting a diagonal pattern of raised tread at toe and heel ends separated by a band of horizontal lines. Photograph provided by Laurie Webster.

2004:91–100); and from southwestern New Mexico at Bat Cave (Dick:1965:76, Figure 49a) and Tularosa Cave (Martin et al. 1952:276–279). Kankainen (1995:33–164) illustrates 38 Scallop Toe Cordage sandals from sites in Arizona and five more from sites in Utah. Unlike the Antelope Cave example, many of these sandals are highly decorated with elaborate colored designs on their upper surfaces and complex geometric raised treads on their soles. Scallop Toe Cordage sandals probably evolved from Square-Toe Cordage sandals in the Four Corners states, and so far the former have not been reported for the Great Basin.

As expected, Scallop-Toe sandals display a number of stylistic and construction variations (see Osborne 2004:93–100). The toe scallop ranges from broad and shallow in the earlier examples to narrow and deep in the later ones. Warps can be 2z-S or 3z-S. Geometric design elements may or may not be present. If recognized, colors and/or raised design patterns also vary. Toe ties are either single or double yucca fiber loops. Heel shapes are square, rounded, or puckered.

Antelope Cave's only Scallop-Toe Cordage sandal comes from a disturbed area. It was found on the surface at the bottom of the Secondary Sink (see Figure 4). The sandal has a radiocarbon date of cal AD 406–542 (see Table 1). Thus, the sandal was made and worn during early Basketmaker III times. There is a 200-year gap between our Scallop-Toe sandal and the closest dated Antelope Cave Square-Toe Cordage sandal (AD 56–217) and a 140-year gap between the Scallop-Toe sandal and the earliest Pueblo I style sandal (AD 680) at Antelope Cave. Webster (2012:171–175) summarizes the geographic and temporal extent of Basketmaker and Pueblo 1 cordage (twined) sandals and suggests that because of their complex construction and applied design patterns, the more finely woven and highly decorated sandals from these periods may have served social or ritual functions in addition to protecting peoples' feet.

Stratigraphic Sandal Distribution Summary

The oldest Antelope Cave Basketmaker II sandals, 2-Warp Plain Weave Wickerwork, were also the deepest in the Basketmaker midden deposit in units AC59-3 and AC59-4. The two 2-Warp Plain Weave Wickerwork sandals (244-2459, 244-2516) were found 36 and 38 inches below the surface of unit AC59-4. Sandal 244-2516 has a ^{14}C date of cal 40 BC–AD 87.

Six of the nine Square-Toe Cordage sandals occurred between 18 inches and 36 inches deep in the two Basketmaker units. Sandal 244-2108 in AC59-3 was from the top of the Basketmaker deposit and produced a ^{14}C date of cal AD 3–138. Four of the Square Toe Cordage sandals (244-2430, 244-2460, 244-2461, 244-2462) clustered at a depth between 30 and 36 inches in AC59-4. Fiber from one of these four (244-2460) yielded a radiocarbon date of cal AD 56–217. The remaining three Square-Toe Cordage sandals did not come from the Basketmaker area. Two are fragments (244-2974 and 244-3608) recovered from AC59-5 between 12 and 30 inches from the surface, and one is a complete sandal (153–310) with no provenience.

None of the three Multiple-Warp Wickerwork sandals was found in the defined Basketmaker area. Two of the sandals (153-100 and 153-205) came from excavation unit E between 30 and 48 inches below the surface. The third wickerwork sandal (153-311) lacks provenience. A ^{14}C date of cal AD 66–222 for sandal 153-205 indicates that the Multiple-Warp Wickerwork footwear and the Square-Toe Cordage sandals were probably contemporaneous at Antelope Cave (see Table 1).

Our lone Basketmaker III Scallop Toe Cordage sandal (244-289) unfortunately was not recovered from an excavation unit under controlled conditions but does have a secure radiocarbon date range of cal AD 406–542. It is the youngest Basketmaker sandal from the cave.

Fiber Cordage

The Basketmaker deposit yielded 60 fragments of yucca fiber cordage (Table 6). These include 34 pieces of 2s-Z (57%) cordage and 26 fragments of 2z-S (43%) cordage, as well as three 3-ply Z twist strings and one 4-ply Z twist cord. That the numbers and percentages of 2-ply Z twist and S twist cordage at Antelope Cave are proportionately close is very uncharacteristic of a Basketmaker II deposit. Nevertheless, all of the fiber pieces likely represent discard during the manufacture and repair of sandals and other yucca fiber articles in the cave.

The nine Square Toe Cordage sandals from Antelope Cave also reflect the common use of both Z twist and S twist yucca twine during manufacture (Table 7). Warp and weft elements tend to be 2z-S while toe loops and heel straps are mostly 2s-Z. Sandal 244-2462 has 2s-Z "winter" side loops and lacing. In all, final 2-ply Z twist cordage was employed 14 times in the making of the nine sandals and 2-ply S twisted strings were used 20 times.

The strong preponderance of 2s-Z twist cordage over 2z-S cordage is recognized as one of the defining characteristics of Basketmaker II culture (Haas 2006). At Black Dog Cave, for example, 98% of the cordage is 2s-Z (Winslow and Blair 2003: 249, Table 10). Now, in view of the Antelope Cave data, the very high percentage of 2s-Z cords no longer holds for all Basketmaker II sites. As noted previously, Osborne (2004:89–91) suggests that the slow change from dominant Z twist warps in Basketmaker II sandals to the dominance of S twisted warps in Basketmaker III sandals may have begun before Basketmaker III times. Perhaps we should extend her argument to include the gradual twist change in yucca fiber twine from 2s-Z dominance in early Basketmaker II times to a notable percentage decrease by late Basketmaker II. The particulars of where and when this change began are undetermined. However, it was happening at Antelope Cave between 40 BC and AD 217. It is reasonable to suggest that some late Basketmaker II sites dating after AD 1 likely will show 2s-Z yucca fiber string percentages falling to 60% or less and 2z-S twisted cords concomitantly rising to 40% or more.

Table 6. Distribution of 2-ply Yucca Fiber Cordage in the Basketmaker Deposit

	AC59-3		AC59-4	
	2s-Z	2z-S	2s-Z	2z-S
Depth (in.)				
18–24	5	8	6	1
24–30	3	1	5	0
30–36	2	4	6	6
36–42	1	0	5	6
42–48			1	0
Total	11	13	23	13

Table 7. Occurrence of 2s-Z and 2z-S Cordage in Square Toe Cordage Sandals at Antelope Cave

Sandal #	Warps		Wefts		Toe loops		Heel straps	
	2Z	2S	2Z	2S	2Z	2S	2Z	2S
153-310	+	+	-	+	-	-	-	-
244-2108	-	+	-	+	+	-	+	+
244-2367	-	+	-	+	+	-	+	-
244-2430	+	+	-	+	+	-	+	-
244-2460	-	+	-	+	+	-	-	+
244-2461	-	+	-	+	+	-	+	-
244-2462	+	+	-	+	+	-	+	-
244-2974	-	+	-	+	-	-	-	-
244-3608	-	+	-	+	-	-	-	-
Total	3	9	0	9	6	0	5	2

Twined Seed Beater

Twined weaving in the Basketmaker deposit is only represented by one fragment of an open simple twined item that resembles a crude seed beater (Figure 26). Warp and weft elements are semiflexible and have not been identified but appear to be mainly unaltered yucca leaves. For the most part, cortex is retained on all the parts. Weft rows are each composed of two elements z twisted around single warps and are spaced approximately 2.4 cm apart. Warps are spread 0.2–0.5 cm apart. The artifact measures 39.5 cm long by 11.0 cm wide. It was recovered 20 inches below the surface in AC59-3.

The tentative seed beater function of this open twined object remains speculative, and similar pieces from Basketmaker contexts are unknown. Guernsey (1931:78, 79, Plate 11) describes examples of simple twining with yucca leaves from Broken Roof Cave and Cave 1, Segi in northeastern Arizona, but these resemble baskets more than seed beaters.

Hairbrush

A strip of sinew was wrapped several times around a small bundle of unidentified semirigid fibers to create a hairbrush (Figure 27). Strands of black human hair are still ensnared in the bristles. This grooming implement (244-2526) was found in AC59-4 in the 36–42-inch level. It is 5.8 cm long and 2.2 cm in diameter. Brushes similar in structure and style were recovered from the Basketmaker Cave I in the Marsh Pass area of northeastern Arizona (Kidder and Guernsey 1919:167, Plate 74). However, brushes of this particular type are rare in Basketmaker sites. The estimated age of the Antelope Cave hairbrush is between 40 BC and AD 87 based on the radiocarbon date of the 2-Warp Plain Weave sandal discovered nearby.

Corncob with Grass

A corncob without kernels was found in the 30–36-inch level of AC59-4. Some stems of unidentified grass had been inserted into one end of the cob (244-2453). Seven similar artifacts with inserted sticks instead of grass were recovered by UCLA from the Pueblo deposits in the cave. Janetski et al. (2013:83) report five more from their Antelope Cave excavations. Corncobs mounted on sticks and/or with inserted feathers appear to be primarily, but not exclusively, a Puebloan trait (e.g., Dick 1965:86; Haury 1945:54; Kidder and Guernsey 1919:99, Plate 34; Lindsay et al. 1969:69; Martin et al. 1954:206, Fig.102; Morris 1980:139; Osborne 2004:466; Winslow and Blair 2003:485, 491). In their Atlatl Rock Cave report Geib et al. (2007:II.2.44, Table 2.9) call two of these objects skewered cobs. The cobs with sticks inserted at one end and feathers at the other end are similar to Hopi examples used in a dart game. The Antelope Cave cob with inserted grass at one end does not appear to be part of a dart game, but its function is unclear.

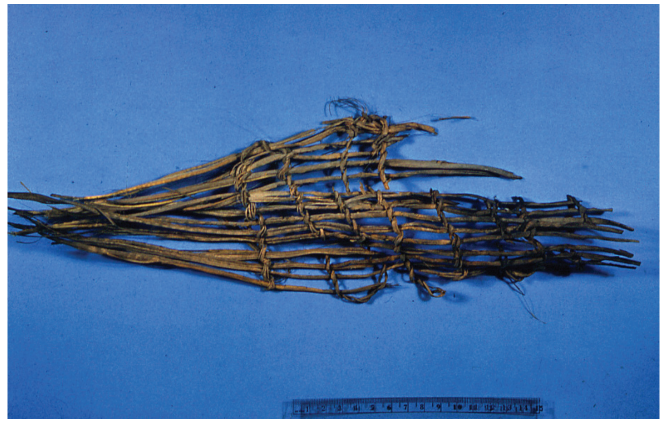


FIGURE 26. Open simple twined seed beater fragment (244-2128).

FIGURE 27. Hairbrush (244-2526).

Quids

These are defined as uncharred wads of yucca fiber that have been chewed or sucked by a site's prehistoric inhabitants (Adams et al. 2015:310, Fig. 5A). UCLA excavations at Antelope Cave yielded 345 quids, but only one (244-2385) came from the Basketmaker deposit. It measures 5.0 cm long by 2.6 cm wide and is 1.0 cm thick. Unlike most of the yucca quids from a sample of 30 analyzed for their contents, the Basketmaker quid did not contain tobacco (Adams et al. 2015: Table 3).

Fiber Wads

Fifteen wads of yucca fiber and one of juniper came from the Basketmaker deposit. Some of these look like quids, though they lack evidence of chewing or the infusion of tiny bits of plants or other materials. Some are too large to comfortably fit in a person's mouth. Their purpose or purposes are unknown as none were discovered in association with objects suggestive of their function.

Rabbit Skin/Fur Cordage

Rabbits were the animals most hunted by the Basketmaker and Pueblo peoples who resided at the cave (Fisher et al. 2013:149; Fisher and Johnson 2014:311, Table 3). Leporids were not only an important food resource, but they also provided skins and fur for blankets and other artifacts. The Basketmaker deposit contained 87 scraps of rabbit fur or fur with skin attached (Fisher et al. 2013:152, Table 4). In addition, there were six twisted strips of skin with fur. Of these one is 1-ply Z, four are 2-ply Z and one is 2-ply S twisted. Strip lengths range from 17.1 cm to 6.5 cm long and widths from 1.4 cm to 0.2 cm. Only one twisted fur/skin strip was found wrapped around a 2s-Z yucca fiber cord. Two untwisted strips of animal hide and one small piece of skin without attached fur also were recovered from the Basketmaker midden.

Rattle

An animal hide (rabbit?) rattle mounted on a peeled, straight wooden stick (244-2130) was discovered 20 inches below the surface in AC59-3 (Figure 28). The rattle's pouch had been made by folding a rectangular piece of hide in half, inserting a stick through the center of the folded skin, placing several kernels of corn in the pouch for rattles (Figure 29), and then sewing the pouch shut around three edges with a 2s-Z yucca fiber cord. The pouch was secured to the wooden handle with 2s-Z yucca cordage. Considerable wear and polish on the handle reflect the rattle's abundant use. The stick measures 35.6 cm in length and its diameter is 0.8 cm. The animal skin pouch containing the rattles is 5.0 cm by 5.7 cm and is approximately 3.5 cm thick. As far as I can determine, this rattle is a unique Basketmaker artifact. It dates between AD 3 and 138 based on the radiocarbon age of a Square-Toe Cordage sandal (244-2108) located in the same excavation unit and level.

FIGURE 28. Animal skin (rabbit?) rattle with a wooden handle (244-2130).

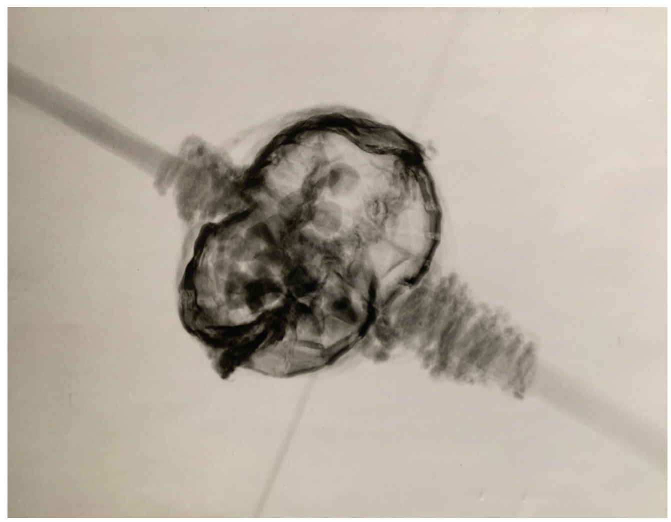


FIGURE 29. X-ray photograph of rattle 244-2130 showing corn kernel rattles inside the skin pouch. X-ray by Theodore T. Ott, Radiology Laboratory Technician, UCLA Medical Center, July 17, 1959.

Human Hair

Some human hair cordage is known for the Antelope Cave Puebloans (Janetski et al. 2013) but none was recovered from the designated Basketmaker area. However, five small tufts of cut human hair were found together in AC 59-4 at a depth of 18–24 inches.

Feathers

Forty-one unmodified and as yet unidentified feathers were found in the Basketmaker deposits. No doubt most were brought into the cave by human conveyance and some were probably intended for the manufacture of ornaments and feather robes and for arrow and dart fletching. Janetski et al. (2013:Figure 2.17) and Johnson and Pendergast (1960:Plate 7) illustrate typical Pueblo I feather ornaments from Antelope Cave. It is assumed the Basketmaker inhabitants made similar feather adornments.

Modified feathers number only three from the Basketmaker midden. One is a scrap of skin with feathers attached. Another is a large feather with trimmed barbs and a narrow strip of animal skin wrapped around its quill tip. The third is a z-twisted skin strip with attached feathers.

Bone Awl

UCLA archaeologists recovered very few artifacts of animal bone at Antelope Cave (Johnson and Pendergast 1960:7). This may be due in part to the fact that the cave's hunters focused primarily on collecting rabbits rather than shooting larger game some of whose bones could have been used to produce the typical array of Puebloan bone objects. A bone bead (see below) and a broken awl, however, were recovered from the Basketmaker area. The awl fragment (244-4585), a splinter from an artiodactyl long bone, came from the 30–36-inch level of AC59-3. It is 7.6 cm long, 0.7 cm wide and 0.3 cm thick. A piece including the awl's tip has broken off lengthwise, thus reducing the width of the original tool. Over 75% of the awl's surface has been polished.

Atlatl Darts and Arrows

UCLA excavators recovered three worked hardwood sticks tentatively identified as darts. One is the straight piece of a stem 25.9 cm long by 1.4 cm in diameter that is split longitudinally. This item (244-2358) came from AC59-4, 18–24 inches below surface. Before being split, the bark had been removed from the shaft and the uncovered surface smoothed. One end is cut and very slightly burned. The other end comes to a natural point as a result of the longitudinal split. The second specimen is also a straight main shaft fragment (244-2551) and, like the first, has been split lengthwise after the bark had been peeled off the object and its surface smoothed. One end appears to have been cut, the other end snapped off. It is 15.5 cm long, 0.6 cm wide and comes from the 42- 48 cm level in unit AC59-4. The third specimen is part of a foreshaft (244-2134) from AC 59-3, 18–24-inch level. It measures 3.0 cm long and 0.9 cm in diameter and is broken off at the distal end. The debarked surface has been roughly tapered to the proximal end which was ground flat.

These three objects are intuitively identified as dart fragments. They could just as easily be broken arrows. As fragments, they unfortunately do not display any attributes that would facilitate their correct classification. For many decades, Great Basin and Southwestern archaeologists have distinguished between dart and arrow fragments by diameter size. For example, dart fragments are reported to have diameters greater than 0.9 cm, and arrow pieces measure less than 0.9 cm. In 1960 Gordon Grosscup (1960:33, 34) questioned the use of 0.9 cm as the metric dividing point between darts and arrows. Using data primarily from Lovelock Cave, Grosscup demonstrates it is not possible to distinguish darts from arrows on the basis of diameter measurements of foreshafts and main shafts when other diagnostics elements are not available, but his conclusions have not been readily accepted (e.g., Dalley 1970:184, 1976:58; Janetski 1980:77; Janetski et al. 2013:56). Winslow and Blair (2003:352, 358) determined without explanation that the diameter dividing point distinguishing Black Dog Cave darts from arrows is 0.8 cm. In Mesa Verde, diameter measurements of 19 arrow shafts range from 0.7 cm to 1.0 cm; 0.8 cm is most common (Osborne 2004:243).

At Bighorn Cave, Hovezak and Geib (2002:115) describe three wooden foreshafts and main shaft fragments that they suggest are arrows or darts, but they are unwilling to make definite identifications based on the diameter measurements of each piece. It appears they have found the best way to classify these two kinds of weapons when fragments lack defining attributes.

Reed Artifacts

Four small broken artifacts of cane were found in the Basketmaker deposit. Three came from the top Basketmaker level, 18–24 inches, and one (244-2454) from level 30–36 inches. Specimen 244-2133 measures 5.6 cm long. It has been smashed lengthwise into four pieces, all held together with sinew wrapping near one end. Both ends are broken and jagged. The second object (244-2362), split lengthwise, is 2.3 cm long and 1.0 cm in diameter. One end has been cut and snapped off. The opposite end is uncut but burned after the piece was broken apart. The third fragment (244-2363), also split lengthwise, is 6.0 cm long and broken at both ends. It shows no further modification. The last cane artifact (244-2454) is 4.5 cm long and 0.9 cm in diameter. Both ends are broken off; one is jagged and the other was grooved and then snapped off. A thin, partially black (painted?) material adheres to more than half of the object's surface. The function or functions of these reed fragments could not be determined. It is probable that one or more of them represent parts of arrows or darts.

Digging Stick

This is a peeled and polished stick that has a slight natural curve at one rounded and burned end. The opposite end is broken off. Recovered from AC59-4 at a depth of 30 inches, the stick is 63.5 cm long, 2.5 cm wide and 2.1 cm thick. Because of its size and shape, it was likely used as a digging or planting stick, but that cannot be confirmed.

Modified Wood Fragments

Ten specimens that are too fragmentary to classify fit this category. One flat object (244-2555) has been polished on two sides and its unbroken edge. It is from AC59-4, the 42–48-inch level and is 15.3 cm long, 1.7 cm wide, and 0.9 cm thick. Both sides display black painted, wavy-band designs. Another wood fragment (244-2553) with the same provenience as the one just described, is 5.8 cm long, 1.1 cm wide, and 0.7 cm thick. It is not polished but has a rounded, burned end and a purple stain over most of its broken surface. Six polished wood fragments

Table 8. Distribution of Pottery Sherds, Basketmaker Area, Antelope Cave

	AC59-3				AC59-4					
Depth (in.)	**18–24**	**24–30**	**30–36**	**36–42**	**18–24**	**24–30**	**30–36**	**36–42**	**42–48**	**Total**
North Creek Gray	5	–	–	–	13	4	–	–	–	22
North Creek B/G	1	–	–	–	3	1	–	–	–	5
Lino B/G	1	–	–	–		1	–	–	–	2
Shinarump Brown	1	–	–	–	4	–	–	–	–	5
Yellow Paste	2	–	–	–	–	–	–	–	–	2
Total	10		–		20	6				36

(244-2164, 244-2195, 244-2359, 244-2360, 244-2552, 244-2554) come from four Basketmaker levels in AC59-3 and 4. Of these, four specimens are burned, and another has its unbroken end ground flat. The last two (244-2135, 244-2553) of the 10 pieces in this category are unpolished sticks with rounded burned ends.

Ceramics

In 1961 David Pendergast studied the ceramics from UCLA's excavations at Antelope Cave. He sorted 3,618 sherds from units AC59-1 through AC59-4 into 16 pottery types. Sherds from five of those pottery types were recovered in the Basketmaker midden (Table 8). Karen Harry and James Allison (personal communications 2018) agree that the five types are currently valid. Allison, however, suggests that the Lino Black-on-gray sherds would probably be called Washington Black-on-gray today. The two sherds listed as Yellow Paste on Table 8 represent a new unnamed pottery type. The sherds in this category have yellow-orange surfaces, yellow to gray colored cores and quartz sand temper.

All 36 pottery pieces from the Basketmaker midden (see Table 8) likely represent intrusions from the Pueblo deposits directly above. Age-wise, the sherds typically date to the Pueblo I and Pueblo II periods. The intrusive pottery may be largely a result of the action of relic collectors. Before excavation of the two Basketmaker units AC59-3 and 4 began, a pothunter's pit was noted and recorded. The depression, six inches deep, extended across almost all of the surface of the two units. Much of the midden deposit had been disturbed to a depth of at least 12 inches (see Figure 8).

Beads

The Basketmaker midden yielded three beads. One is of bone and two are made of stone. The bone specimen (244-2456) came from AC59-4, 30–36-inch level. It is a polished tube bead from a small mammal. Cut at both ends, it is 1.5 cm long by 0.4 cm wide. A black lignite disk bead (244-2357) was found in AC59-4 at a depth of 18 -24 inches. The bead is 0.8 cm in diameter and 0.1 cm thick. It has a central conical perforation. The third specimen is a polished light green stone disk bead (244-2181) from AC59-3, level 30–36 inches. It is 1.3 cm in diameter, is 0.3 cm thick and has an off-center conical perforation.

While many Basketmaker collections have bone and stone beads, only a few contain black lignite disk beads (e.g., Gourley 2018; Morris 1980:77; Morris and Burgh 1954:71; Winslow and Blair 2003:454). The popularity of these beads increased through time, and they are found in Pueblo period collections across the Puebloan homeland from Antelope Cave (Janetski et al. 2013:41) to Cliff Palace on Mesa Verde (e.g., Fewkes 1911:75). These flat black beads are also common in Fremont sites north of the Puebloan region (Janetski et al. 2011:31; Meighan et al. 1956:54, 74). To date prehistoric black lignite quarries in the Southwest have not been identified so it is not yet possible to know how or from where the Antelope Cave Basketmakers obtained these black disk beads.

Manos

UCLA excavations produced only five manos from the cave (Johnson and Pendergast 1960:7). Two are from the Basketmaker area. Specimen 244-2148 from pit AC59-3, 20–34-inch level, is a bifacially modified sandstone cobble. It is 14.0 cm by 9.5 cm and is 6.4 cm thick. The other mano (244-2452) from AC59-4, 30–36 inches below the surface, is a unifacially modified square piece of limestone (?) that shows secondary battering along one edge. The dimensions are 12.8 cm by 12.0 cm by 5.5 cm thick. Both manos appear to be one-hand Basketmaker grinding tools.

Metates

Thirteen thin slab metates were recovered by UCLA. One came from the Basketmaker area. All of these grinding stones are quite small, exhibit little use, and most are fragments of larger pieces. The Basketmaker example (244-2356) is a broken piece of sandstone from AC59-4, 18–24-inch level. Length is 7.6 cm; width, 3.7

Table 9. Distribution of Chipped Stone Artifacts, Basketmaker Area, Antelope Cave

	AC59-3				AC59-4					
Depth (in.)	**18–24**	**24–30**	**30–36**	**36–42**	**18–24**	**24–30**	**30–36**	**36–42**	**42–48**	**Total**
Cores	–	–	–	–	–	1	1	–	–	2
Debitage	17	7	6	6	14	4	2	28	14	98
Wrapped flakes	1	–	–	–	–	–	–	–	–	1
Utiliized flakes	2	–	4	–	2	2	1	4	3	18
Bifaces	–	1	–	–	2	–	1	3	–	7
Projectile points	1	1	–	1	–	–	2	–	–	5
Total	21	9	10	7	18	7	7	35	17	131

cm; and thickness, 1.8 cm. The limited use-wear on the grinding surfaces of the metates at Antelope Cave points to the small number of people who lived in the cave at any given time and indicates their stay was always short and likely seasonal.

Cores

Two cores, one of gray chert/chalcedony and one of gray quartzite, were found in AC59-4 (Table 9). The former has been battered and may have been used as a hammerstone. The larger quartzite specimen measures 6.5 cm by 4.7 cm.

Debitage

Waste flakes from the Basketmaker area number 98 (see Table 9). Of these, 61 are chert/chalcedony, two are black obsidian, and the remainder remain unidentified. Judging from the paucity of lithic detritus, the manufacture and resharpening of stone tools took place in the cave but was not a major activity there during the late Basketmaker II period.

Fiber Wrapped Flakes

Two apparent waste flakes of about the same size and roughly rectangular in shape were placed one atop the other and wrapped several times with juniper bark to hold them together (Figure 30). The two flakes of light gray chert were found 18 inches below the surface of AC59-3 and measure approximately 4.1 cm long by 3.0 cm wide. Their purpose is unknown. It appears that wrapped together they are a unique Basketmaker II artifact. Objects similar, but not identical, are reported for Winchester Cave east of Tucson (Fulton 1941:24). They are called wrapped discs and are composed of pottery sherd pairs, not waste flakes.

Utilized Flakes

These are usually small, thin flakes of chert/chalcedony that exhibit edge modification from use and/or retouch activity. There are 18 of these from the Basketmaker deposit (see Table 9). A typical example is 244-2493. It retains a tiny bit of the platform from which it was struck as well as the bulb of percussion. Made of gray chalcedony, this small tool measures 4.3 cm by 2.5 cm and is 0.6 cm thick.

Bifaces

These are flaked tools that have been chipped on both faces and usually are leaf shaped or triangular in form. They have been variously named projectile points, blades, knives, blanks, and preforms. Currently, most bifaces are described as unstemmed and unnotched flake tools representing stages along a trajectory leading to finished projectile points (see Andrefsky 1998:180–188). Of course, some bifaces were used for scraping and cutting activities along the way (e.g., Weder 1980:39).

The UCLA Basketmaker units yielded seven bifaces (see Table 9) of which three are fragments. One is a Stage 3 biface and the rest are Stage 4 (Andrefsky 1998). The largest biface (244-2488) at Stage 3 is made of gray chert and measures 8.8 cm by 3.6 cm and is 0.6 cm thick (Figure 31 on right). Five Stage 4 bifaces, including three fragments, are leaf shaped and made of chert/chalcedony. The last biface (244-2153) at Stage 4 is triangular in shape and manufactured from black obsidian (Figure 32a).

Projectile Points

Only five projectile points were found in the Basketmaker deposit (see Table 9). Of these, four are broken or unfinished, and one is complete. The incomplete specimens are of quartzite (1), chert (1), and obsidian (2) (Figure 32b and c). The complete point

FIGURE 30. Two waste flakes wrapped in juniper bark fiber (244-2107); length, 4.1 cm.

FIGURE 31. Stage 3 biface (244-2488) at the bottom is from AC59-4, on the right is from AC59-4, level 36-42. Biface on the top is from the Puebloan deposit. Length of 244-2488 is 8.8 cm; other to scale.

FIGURE 32. Obsidian Basketmaker artifacts: a) biface; b) and c) unfinished or broken projectile points. Length of biface, 3.4 cm; others to scale.

FIGURE 33. Dart points from the UCLA Antelope Cave collection. The Basketmaker Eared point (244-2152) from AC59-3 is at the far right. The other three points are not from the Basketmaker units.

Table 10. Obsidian Sources of Projectile Points and Biface from Antelope Cave

Cat. No.	Object	Unit	Depth (in.)	Culture	Figure	Obsidian Source
244-412	Proj. pt.	AC59-1	6 –12	P I	–	Panaca Summit, Modena NV/UT
244-2105	Proj. pt.	AC59-3	18 –24	BM II	32c	Panaca Summit, Modena NV/UT
244-2210	Proj. pt.	AC59-3	36 –42	BM II	32b	Unknown Type B
244-2153	Biface	AC59-3	24 –30	BM II	32a	Kane Springs Wash Caldera, NV (Variety 1)

(244-2152), fashioned from quartzite, I have tentatively named Basketmaker Eared (BM Eared). It measures 6.0 cm long by 2.2 cm wide by 0.7 cm thick and weighs 9.3 g (Figure 33, on right). It has straight, parallel sides, is corner-notched with round or straight shoulders, and a concave base. Its Dart-Arrow Index (DAI) value of 19 mm indicates it is a dart point (Hildebrandt and King 2012). The quartzite BM Eared point came from AC59-3 in level 24–30 inches and is tentatively dated between AD 3 and AD 217 based upon the radiocarbon dates obtained from nearby Square-Toe Cordage sandals (see Table 1). At first glance, the BM Eared point resembles an Elko Eared point. This type was initially defined by Heizer and Baumhoff (1961:126, 128) at Wagon Jack Shelter in central Nevada and is found at sites throughout the Great Basin (e.g., Davis and Smith 1981; Fowler et al. 1973; Hanes 1977; Holmer 1980; Jennings 1957; Pendleton 1985; Thomas 1985) but it appears to be absent from Puebloan sites. However, other types of Elko points have been reported from Virgin Puebloan sites. Elko Side-notched points were found at Black Dog Cave (Winslow and Blair 2003) and both Elko Side-notched and Elko Corner-notched points came from excavations at Rock Canyon Shelter (Janetski 2017) and Jackson Flat (Janetski 2018). Elko series points range in age from 5750 BC to AD 700 (Smith et al. 2013:588; Thomas 1981:32).

Recently Phil Geib (2011) and R. Jane Sliva (2015) reviewed Western Basketmaker II projectile points, but the Antelope Cave dart point does not fit comfortably into any of their carefully defined standard types. In fact, the Antelope Cave BM Eared point has characteristics of both Basketmaker II and Elko Eared points. For example, Elko series points should have triangular blades (Geib 2011:269, Figure 5.33) whereas Basketmaker II points have lanceolate-shaped outlines. The shape of the Antelope Cave point is more like Basketmaker II than Elko Eared. Elko points characteristically have barbed shoulders unlike the straight shoulders of Basketmaker points and the Antelope Cave BM Eared point. The most visually obvious difference between these two point styles, however, is that Elko Eared points and the Antelope Cave BM Eared point display a characteristic notched or concave base rarely found among Western Basketmaker II dart points.

The BM Eared point is so named to distinguish it from the multitude of Elko Eared points ostensibly produced from the same mental template for 6,000 years. Unlike Elko Eared points this new Basketmaker dart point is specific to one archaeological culture and one short time period in the prehistoric past. Could the Antelope Cave BM Eared point warrant definition of a new type or subtype of Basketmaker II dart point? Possibly, but not until similar examples are recognized at more archaeological localities.

Obsidian Sources

UCLA recovered a total of four obsidian tools from Antelope Cave. Of these, two are projectile point fragments and one is a biface, all from the Basketmaker deposit (see Figure 32). A third obsidian point fragment (244-412) came from Pueblo I debris in AC59-1, 6–12 inches depth. The four objects were submitted for sourcing to the Geoarchaeological XRF Laboratory in Albuquerque. Results are presented in Table 10 (M. Steven Shackley, personal communication July 17, 2014). Two of the projectile points came from the Panaca Summit obsidian source near Modena on the Nevada/Utah border. That source is about 85 miles northwest of Antelope Cave. The third projectile point is from an as yet unlocated source called Unknown Type B. Examples from this source are fairly common at archaeological sites on Nellis Air Force Base just outside of Las Vegas, Nevada (Haarklau et al. 2005). It is assumed that this unknown obsidian source is hiding somewhere in the southern Nevada/Utah area. The biface from Antelope Cave originated at Kane Springs Wash Caldera (Variety 1) in Nevada. This source is about 21 miles southwest of Modena. It is not possible to determine how the cave's inhabitants obtained the obsidian, either by trade or travel. The paucity of obsidian detritus in the cave suggests that the points probably were neither manufactured nor significantly reworked at Antelope Cave. Notable is the fact that at Antelope Cave both Pueblo I and Basketmaker II groups used obsidian points originating from the same source near Modena.

Basketmaker II sites at Jackson Flat Reservoir about 50 miles east of Antelope Cave contained obsidian

Table 11. Distribution of Coprolites in the Basketmaker Deposit, Antelope Cave

Depth (in.)	AC59-3	AC59-4	Total
18–24	12	3	15
24–30	3	3	6
30–36	3	13	16
36–42	2	8	10
42–48		6	6
Total	20	33	53

objects from the Panaca source near Modena in Nevada and from Wild Horse Canyon in central Utah (Janetski 2018:164–167). Black Dog Cave located 50 miles north of Las Vegas and about 70 miles west of Antelope Cave obtained obsidian from four different sources, one of which was Wild Horse Canyon (Winslow 2009:803, 804, 844). It is likely all the Virgin Branch Puebloans knew each other directly or indirectly through the networks that supplied them with obsidian from the Panaca and Wild Horse Canyon sources.

Red Ochre

One small chunk of hematite was obtained from the 18–24-inch level of AC59-3. Ground into a powder or mixed as a paint, this mineral provides a red color often important in social, political, and religious activities by Native American societies. However, it apparently was little used by the Basketmakers at Antelope Cave and was only evident on the edges of two Square-Toe Cordage sandals (see Table 5).

ANIMAL AND PLANT REMAINS

Coprolites

The analysis of human fecal matter provides insight into the kinds and amounts of plants and animals eaten by the cave's inhabitants, as well as the cultural processes used in the preparation and consumption of food (see Fugassa et al. 2011; Johnson et al. 2008; Reinhard et al. 2012). The total number of human/animal coprolites in the UCLA Antelope Cave collection is 190 of which 20 were subjected to analysis (Reinhard et al. 2012:Supplements A, B, and C).

Unfortunately, of the 20 human fecal pieces selected for study, only two came from the Basketmaker area (Reinhard et al. 2012:Supplement C, pages 1–3). Both were from the same provenience, AC59-4, 30–36-inch level (Table 11). Coprolite number 1 (244-2487) was primarily a meal of roasted pricklypear (*Opuntia* sp.) pads with traces of dropseed (*Sporobolus* sp.) seeds, which were eaten whole without cooking. The pollen present was mainly of grass. Coprolite number 18 (244-2487) contained parched, coarsely ground maize and roasted pricklypear pads along with fragmented small mammal bones. The remains of three termites were probably from a previous meal. The coprolite also yielded thousands of maize pollen grains, mostly fragmented.

Fauna

The bones of hunted jackrabbits and cottontails are by far the most prevalent fauna recovered throughout the UCLA Antelope Cave excavations (Fisher et al. 2013:149 and Table 3). That dominance is characteristic of the Basketmaker area as well, except there are fewer total specimens than in the Pueblo areas of the cave (see Fisher and Johnson 2014:Tables 2 and 3). It is clear that the Basketmakers were the first to utilize the cave primarily as a temporary base to capture leporids and that activity became an Antelope Cave tradition which lasted for 1000 years until the last Pueblo II family left the site around AD 1050 never to return.

The total number of identified specimens (NISP) in the Basketmaker faunal assemblage is 385 (Fisher 2009:Table 2). There are 48 unidentified specimens. The identified NISP is composed of 17 artiodactyls including 7 mountain sheep, 355 leporids including 210 jackrabbits and 142 cottontails, 6 wood rats, 4 pocket gophers, 1 turtle, 1 bat, and 1 woodpecker.

Skeletal analysis indicates that leporids were brought whole into the cave for processing and cooking (Fisher and Johnson 2014). In support of this evidence is the recovery of 254 leporid internal organs (stomachs, ceca, intestines and pellets) and a few ears. The viscera were encountered in all five units excavated in 1959. However, only one rabbit specimen, a cecum, came from the Basketmaker deposit, AC59-3, 18–24 level.

Recent discussions about the probability that the Antelope Cave Puebloans used communal jackrabbit drives to capture their prey appear to be inconclusive (Fisher et al. 2013:153–155; Janetski et al. 2013:156). In the Basketmaker area, the complete absence of rabbit nets and throwing sticks weakens the argument for communal rabbit drives at least before Pueblo I times.

Fisher (2009:26, 31, Table 20) reports significant differences between the faunal materials in the site's Basketmaker and subsequent Pueblo deposits. Artiodactyl remains, including mountain sheep (Ovis canadensis), were most prevalent in the Basketmaker area, although artiodactyls were never very numerous in the cave as a whole. When compared to cottontail rabbit bones, jackrabbit specimens increase dramatically from early to late during Pueblo times but this is not true for the Basketmaker area where the percentages of Sylvilagus and Lepus remains stay fairly stable throughout the late Basketmaker II time period (40 BC–AD 400). The vertebral columns and rib cages are largely missing from the rabbits in the Pueblo areas of the cave but are common among the leporid remains from the Basketmaker area. This is attributed to the fact that, unlike the Basketmakers, the site's Pueblo period occupants probably ground up the missing bones into a paste which was then eaten.

Domesticated Plants

Cultivated plants brought into Antelope Cave survived in large part because of the wonderful preservation conditions provided by the shelter of the cave. Plant remains were significantly less abundant in the Basketmaker area than in the Pueblo deposits due to smaller Basketmaker population numbers and/or less intensive use of the site by Basketmakers.

Corn

The presence of maize in the site separates the Basketmakers from earlier hunting and gathering peoples who were apparently the first humans to inhabit Antelope Cave (Janetski 2017; Janetski et al. 2013). When the first Basketmakers arrived at the cave around 40 BC, maize was already a major domesticated food resource in the Four Corners region (Coltrain et al. 2007:317).

In January 1960 all the Antelope Cave corn (cobs, kernels, corn artifacts, etc.) from the UCLA excavations was sent to Hugh Cutler for analysis at the Missouri Botanical Garden, but he was not able to complete the analysis. Upon his retirement in 1977 the collection was split up, with some sent to the Illinois State Museum in Springfield and the rest to the Department of Agriculture, University of Illinois, Urbana. The corn materials remain at these two institutions to this day.

Before he retired, Cutler made some notes on the maize from AC59-4. Table 12 presents corncob row numbers from the Basketmaker portion of AC59-4. The most numerous cobs had 12 kernel rows, which holds true for the cobs in the Pueblo areas as well (Cutler and Blake 1987: Appendix I; Janetski et al. 2013).

Table 13 summarizes Cutler's analysis of some of the corn grains from the Basketmaker deposit. There was no information on level 30–36, so it is not included in the table. Cutler recognized at least six types of maize kernels. Only five are shown in Table 13. Flint corn grains are by far the most numerous, which is typical at other Basketmaker sites (e.g., North Shelter, Jones and Fonner 1954:109; Sand Dune Cave, Cutler 1968:375; White Dog Cave, Guernsey and Kidder 1921:41, 42). That this is the most popular Basketmaker corn at Antelope Cave supports the argument that flint corn is a diagnostic trait of Basketmaker II culture. Flour kernels are in the majority in the cave's Pueblo deposits (Janetski et al. 2013:83, 91) and flour corn is the most preferred at other Pueblo period sites (e.g., Antelope House, Hall and Dennis 1986:128; Mug House, Cutler and Meyer 1965:141–142). Yellow or white dent corn did not occur in the Basketmaker unit but was recovered in small quantities in the Pueblo deposits. Although Cutler identified popped corn from the Basketmaker midden, the notes in my possession do not indicate its distribution in AC59-4, and so it does not appear in Table 13.

Calico kernels in Table 13 refer to grains that are red with vertical streaks of yellow or white. Red streaked or striped corn kernels are not often discussed in the archaeological literature (see Cutler 1968:375; Jones and Fonner 1954:109 for exceptions) and thus the prehistoric distribution of this type of maize in the American Southwest is largely unknown. The ethnographic literature indicates that red streaked corn kernels were supernaturally important in western Mexico and among the Navajo where they served as charms to assure a bountiful maize harvest (Bohrer 1994:493, 511). The ritual use of red streaked/striped corn has not been confirmed for the prehistoric Basketmakers.

Table 12. Distribution of Corncobs by Number of Rows from AC59-4

Depth (in.)	Number of Kernel Rows							Total
	8	10	12	14	16	18	20	
18–24	1	6	7	1	1	2	1	19
24–30	–	–	5	4	–	–	–	9
30–36	1	5	5	4	–	1	–	16
36–42	–	–	1	5	1	–	1	8
42–48	1	–	–	1	1	2	–	5
Total	3	11	18	15	3	5	2	57

Table 13. Distribution of Corn Kernels, Basketmaker Area, AC59-4

Depth (in.)	18–24	24–30	36–42	42–48	Total
Yellow Flint	46	37	62	38	183
Yellow Flour	11	8	4	26	49
Cherry Flint	15	11	11	6	43
Cherry Flour	5	3	1	2	11
Calico	3	1	4	1	9
Total	80	60	82	73	295

Table 14. Distribution of Squash and Wild Plants, Basketmaker Area, Antelope Cave

	AC59-3				**AC59-4**					
Depth (in.)	**18–24**	**24–30**	**30–36**	**36–42**	**18–24**	**24–30**	**30–36**	**36–42**	**42–48**	**Total**
Cucurbita sp										
C. pepo seeds	2	–	1	2	7	7	8	5	3	35
C. mixta seed	–	–	–	–	–	–	1	–	–	1
unident. seeds	–	–	–	–	–	–	1	4	2	7
rind fragments	1	1	–	–	–	–	2	1	–	5
Atriplex h.										
leaves	–	–	–	–	3	–	1	–	–	4
seed	–	–	–	–	1	–	–	–	–	1
Ephedra sp.	–	–	–	–	–	1	–	–	–	1
Juniperus o.										
berries	4	–	–	–	–	1	–	1	–	6
bark	–	1	–	4	–	1	– –	–	–	6
Opuntia sp.										
fruit/pads	70	8	–	–	–	–	31	6	3	118
seed	–	–	–	–	–	–	–	1	–	1
Panicum u.										
seed	–	–	–	–	–	–	1	–	–	1
Pinus m.										
nuts	11	3	4	3	11	9	11	5	2	59
Quercus sp.										
nuts	–	2	2	2	–	2	–	1	–	9
Wild grass	–	1	–	3	–	5	2	5	1	17
Wood sticks	–	–	1	3	–	–	–	–	–	4
Yucca sp.										
seeds	–	10	120	23	6	–	–	8	64	231
spines	–	1	–	–	–	–	–	1	–	2
pieces	–	–	–	–	–	2	–	–	–	2
fiber	–	–	–	–	–	3	1	2	–	6
Unidentified	–	–	1	–	5	–	–	–	1	7
Total	88	29	129	38	33	31	59	40	76	523

Beans

UCLA excavations at Antelope Cave yielded 83 examples of the common bean (*Phaseolus vulgarus*); however, only one was recovered from the Basketmaker deposit (AC59-4, 18–24-inch level). In 1960, all the beans were sent to Lawrence Kaplan at Roosevelt University in Chicago. He identified the Basketmaker bean as type C13, a Pinto bean (Kaplan 1956), one of three of this type in the UCLA collection. The great majority of the common or kidney beans from Antelope Cave are type C11 (n=57) and were found in the Pueblo I, II deposits. The one bean in the Basketmaker deposit is not really enough to substantiate the growing of this cultigen at Antelope Cave before AD 680.

Squash

The Basketmaker deposit yielded 48 cultivated squash seeds and rind fragments (Table 14). Cucurbita pepo seeds were by far the most prevalent squash remains and, in this regard, do not differ significantly from squash percentages at other Ancestral Puebloan sites. No specimens of the bottle gourd (*Lagenaria* sp.) were found in the Basketmaker midden but were present in the Pueblo deposits at Antelope Cave.

Wild Plants

Table 14 shows the distribution of the 475 (10 genera) non-cultivated plants recovered from the Basketmaker excavation. Ethnographically, Native Americans gathered seven of these different plants for food. They are desert holly (*Atriplex hymenelytra*), juniper berries (Juniperus osteosperma), pricklypear (*Opuntia* sp.), desert panic grass (*Panicum urvilleanum*), pine nuts (*Pinus monophyla*), acorns (*Quercus* sp.) and yucca seeds (*Yucca* sp.). The coprolites previously discussed evidence the Basketmaker II consumption of pricklypear and dropseed (*Sporobolus* sp.) and it is assumed that all the other plant remains brought into the cave were used in some way by the prehistoric inhabitants.

Referring back to Table 14, it appears that pricklypear pads followed by pine nuts were the most important wild plant food resources of the Antelope Cave Basketmakers. Yucca seeds were probably eaten also, but the most significant uses of this plant were for the manufacture of twine and, of course, sandals.

Geib (2011:229–230), Minnis (1989) and others discuss the importance of edible wild plants that thrived in agricultural fields and other places where the ground was disturbed by the Puebloans. This was an added benefit for the Puebloans who not only enjoyed the maize, beans and squash they grew but also the nutritious wild plants that sprang up in their agricultural plots. The wild edible “garden” plants included beeweed, bugseed, goosefoot, pigweed, purslane, sunflower, wolfberry, and other weedy foods. The Basketmaker II groups inhabiting Antelope Cave received some nourishment from a number of wild plants such as panicgrass (*Panicum* u.), dropseed (*Sporobolus* sp.), and several unidentified grasses all of which may have been harvested in fields established for agriculture. I am not aware of the potential locations of those fields in the vicinity of the cave.

SUMMARY AND CONCLUSIONS

Antelope Cave served as a secondary habitation site (Geib 2011:240), logistical node (Janetski 2017:234), or persistent place (Schlanger 1992:92, 97) for Basketmaker groups between 40 BC and AD 542. They came to the cave intermittently as one or two households to hunt rabbits, harvest maize and squash, and gather wild plant foods. Each visit to the site was short in duration because there is no evidence of houses or storage pits and the midden deposit yielded minimal cultural materials. Coprolite analysis (Reinhard et al. 2012:509) and the lack of storage facilities (Geib 2011:242) indicate that site occupation was seasonal in late summer or early fall, but probably not every year. Adequate rain and the likely abundance of water in Clayhole Wash and its water pockets must have influenced the Basketmakers’ annual decision whether or not to temporarily leave their primary residence and travel to Antelope Cave to hunt small game and harvest cultivated and wild plants available in the area. The primary habitation site of the cave’s residents is not known, but several possibilities have been offered (Janetski 2017:234).

The late Basketmaker II occupation at Antelope Cave securely fits in the Moapa Phase (AD 1-AD 400) of Virgin Branch prehistory as discussed by Janetski (2017:209–211). The subsequent Mt. Trumbull Phase (AD 400–AD 600), representing the transition period between Basketmaker II and III, is not yet clearly defined (McFadden 2016:137). It is identified at Antelope Cave by a single dated scallop toe Basketmaker III sandal.

The earliest agriculture on the Arizona Strip is at Jackson Flat where maize has been radiocarbon dated at 1310–810 BC (Roberts 2018). The earliest farmers at Jackson Flat apparently were migrants from San Pedro sites near Tucson. Around 200 BC Basketmaker II people reoccupied the sites at Jackson Flat. These newcomers were the result of intermarriage between the earlier San Pedro farmers and the local Archaic hunter-gatherers (Roberts and Ahlstrom 2018). At Antelope Cave, Basketmaker II people arrived around AD 1. Where they came from is unknown. No earlier farmers are evident at the cave. Pit house architecture and other evidence at Jackson Flat suggest that the sites were occupied primarily in the winter with families dispersing seasonally to big game hunting locales and other single purpose sites (Roberts and Ahlstrom 2018). Antelope Cave, as a secondary habitation site, may fit this pattern (Fisher, Janetski, and Johnson 2013). Virgin Branch trade networks were useful in Basketmaker II times. Obsidian trade (see above) was not as important as the acquisition of ornaments of shell and turquoise at Jackson Flat. Ornaments of shell and turquoise are unknown for Antelope Cave and Rock Canyon Shelter but shell beads were recovered at Black Dog Cave (Winslow and Blair 2003). Burial offerings at Jackson Flat account for the large number of ornaments.

The yucca fiber sandals recovered by UCLA archaeologists are a significant source of information. The chronology of the late Basketmaker occupation at Antelope Cave was established by direct radiocarbon dating of five square-toe sandals. Pueblo I and Basketmaker II sandal data support the conclusion that the cave's inhabitants were composed of family groups, not adult travelers or male hunting parties. Also, sandal analysis indicates that none of the footwear recovered by UCLA were cached there for future use.

Square-toe Basketmaker style sandals similar to the four types described here are known for several regions inside and outside the Puebloan homeland and represent various time periods. While generally alike, the sandals in each type exhibit variations that may reflect technical, social, and religious differences in individual and group behavior. Antelope Cave's Multiple-Warp Wickerwork sandals are characterized by bolster toes not found on similar sandals elsewhere in the American Southwest or the Great Basin. Square-Toe Cordage sandals at the site have braid-like toe finishes while cordage sandals at other Basketmaker sites feature fringed and/or bolster toes. Antelope Cave's cordage sandals display raised tread patterns but none of the colored designs so notable on footwear at other Basketmaker II and III sheltered localities.

It is generally accepted that Basketmaker II fiber cordage is overwhelmingly 2s-Z twisted. At Antelope Cave however, 2z-S twisted string is proportionately high (43%) compared to 2s-Z cordage (57%) and may reflect a gradual increase in the former leading eventually to 2z-S cordage dominance in Basketmaker III times (Osborne 2004).

Local food and its preparation were critical to prehistoric human survival in the semi-arid environment surrounding the cave. The Basketmaker families at Antelope Cave took full advantage of nearby resources. Based on faunal remains and a recovered human coprolite, the Basketmakers hunted primarily leporids, but took some larger game when available. Exactly how they hunted rabbits eludes us, as few weapons and no nets or traps were found in the Basketmaker deposit. The few bifaces and paucity of lithic debitage also indicate that the production and resharpening of hunting points was not a common activity. Only one identifiable dart point is from the Basketmaker area. It is tentatively named Basketmaker Eared (BM Eared) and appears to share Elko Series attributes along with Western Basketmaker point characteristics.

Killed rabbits were brought into the cave to be processed, cooked, and eaten. As an additional benefit during processing, strips of rabbit skin with attached fur were twisted into cords primarily for the production of robes that provided winter warmth for the families at their primary village away from Antelope Cave. Both cultivated and wild plants growing in the vicinity of the cave were included in the Basketmakers' diet. Flint corn and squash were the domesticated staples; prickly pear cactus, yucca seeds, grasses, and pine nuts provided the most common wild plant foods. Pine nuts, of course, had to be carried to the cave from several miles away.

Containers for food collection, transport and storage were extremely rare in the midden. An open twined seed beater fragment is the only fiber example found and the pottery sherds, plain and black-on-gray, are deemed intrusive from the Pueblo period deposits in the cave.

Seed grinding equipment was rarely encountered during excavation. The one Basketmaker metate is a thin broken sandstone slab that exhibits very little use, no doubt a reflection of the limited time families spent living in the cave.

It is evident that the cave's Basketmaker residents devoted some time to their personal appearance. Many of their finely made Square-Toe Cordage sandals have raised treads with geometric designs and two sandals exhibit red painted edges. Toe finishes differ on some of the footwear giving them a distinctive appearance. Beads of bone and stone were probably worn as necklaces and fiber/sinew hairbrushes helped clean and style their straight black hair. Multiple-feather hair ornaments likely completed the Antelope Cave Basketmakers' list of personal accessories. Except for sandals and pieces of rabbit fur robes, no other clothing elements were recovered during excavations at the site.

Indications of interaction with outside groups by the Antelope Cave Basketmakers are difficult to squeeze out of the archaeological materials. Evidence of violence is not apparent as there are few potential weapons and no human remains in the cave. Trade for stone beads is possible but the lithic sources for them are unknown. However, the origin localities of the obsidian tools in the Basketmaker collection have been identified and they are about 85 miles northwest of the cave. That distance improves the likelihood that the black obsidian tools were obtained through trading networks involving the Basketmakers at Antelope Cave, Jackson Flat and Black Dog Cave.

Religious rituals along with supernatural beliefs may be represented by some of the Basketmaker objects, although the cave excavations produced no features or other direct archaeological evidence in support of this possibility. The unique animal skin rattle filled with corn kernels might signal the performance of group rituals to benefit the cave's inhabitants. Ethnographically, Puebloan rattles accompanied ceremonies to cure sickness, bring success in the hunt, and provide abundant crops of wild and cultivated plants (Lamphere 1983:755–758). The unusual juniper wrapped chert flakes possibly belonged to a shaman or priest and may be imbued with supernatural power (Lamphere 1983:763). Perhaps the few red streaked/striped corn kernels had supernatural significance to the cave's Basketmakers as well. Calico maize kernels in some parts of the ethnographic Southwest promise a plentiful corn harvest.

Because of the wealth of prehistoric information it has yielded and because it still preserves an unknown abundance of unexcavated archaeological materials, Antelope Cave is a special place to Southwestern researchers as well as Native Americans. It is a "red flag" site like Snaketown, Pueblo Bonito, and Cliff Palace (Altschul 1989:275)!

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REFERENCES CITED

Adams, Karen R., Keith L. Johnson, and Terrence M. Murphy

2015 Prehistoric Puebloan Yucca (Yucca) Quids with Wild Tobacco (Nicotiana) Contents: Molecular and Morphological Evidence from Antelope Cave, Northwestern Arizona. *Journal of Field Archaeology* 40(3):310–324.

Adovasio, J. M.

1977 *Basketry Technology: A Guide to Identification and Analysis*. Aldine Publishing, Chicago, Illinois.

Altschul, Jeffrey H.

1989 Modeling as a Management Strategy. In *Man, Models and Management: An Overview of the Archaeology of the Arizona Strip and the Management of its Cultural Resources*, by Jeffrey H. Altchul and Helen C. Fairley, pp. 273–309. Prepared for the Bureau of Land Management by Statistical Research, Plateau Archaeology, and Dames and Moore, Inc. Phoenix, Arizona.

Anderson, Margaret, Marie Blais, and William T. Green

1956 Growth of the Normal Foot During Childhood and Adolescence: Length of the Foot and Interrelations of Foot, Stature, and Lower Extremity as Seen in Serial Records of Children 1–18 Years of Age. *American Journal of Physical Anthropology* 14(2):287–308.

Andrefsky, William, Jr.
1998 *Lithics: Macroscopic Approaches to Analysis. Cambridge Manuals in Archaeology*. Cambridge University Press, United Kingdom.

Berg, Adam M., Stewart Deats, Doug Drake, Joshua S. Edwards, Dennis Gilpin, Jim Hasbargen, Michael O'Hara, and Gordon F. M. Rakita
2003 *Prehistoric Occupation of the Confluence Valley Between the Vermillion Cliffs and Short Creek: Archaeological Investigations of 16 Sites for the Hildale Wastewater Treatment Facility, Hildale, Utah and Colorado City, Arizona*. SWCA Environmental Consultants, Flagstaff, Arizona.

Billinger, Michael, and John W. Ives
2015 Inferring Demographic Structure with Moccasin Size Data from the Promontory Caves, Utah. *American Journal of Physical Anthropology* 156:76–89.

Bohrer, Vorsila L.
1994 Maize in Middle American and Southwestern United States Agricultural Traditions. In *Corn and Culture in the Prehistoric New World*. edited by Sissel Johannessen and Christine AA. Hastorf, pp. 469–512. University of Minnesota Publications in Anthropology No. 5. Westview Press, Boulder, Colorado.

Coltrain, Joan Brenner, Joel C. Janetski, and Shawn W. Carlyle
2007 The Stable- and Radio-Isotope Chemistry of Western Basketmaker Burials: Implications for Early Puebloan Diets and Origins. *American Antiquity* 72(2):301–327.

Cosgrove, C. Burton
1947 *Caves of the Upper Gila and Hueco Areas in New Mexico and Texas*. Papers of the Peabody Museum of American Archaeology and Ethnology, Harvard University, Vol. XXIV, No. 2. Cambridge.

Cummings, Byron
1910 *The Ancient Inhabitants of the San Juan Valley*. Bulletin Number 3, Part 2. University of Utah, Salt Lake City.

Cutler, Hugh C.
1968 Plant Remains from Sites Near Navajo Mountain. In *Survey and Excavations North and East of Navajo Mountain, Utah*, edited by Alexander J. Lindsay, Jr., J. Richard Ambler, Mary Anne Stein, and Philip M. Hobler, pp. 371–378. Bulletin No. 45. Museum of Northern Arizona, Flagstaff.

Cutler, Hugh C., and Leonard W. Blake
1987 Corn from the Median Village Site, Appendix I. In *Median Village and Fremont Culture Regional Variation*, edited by John P. Marwitt, David B. Madsen, and Gardner F. Dalley, p. 163. Anthropological Papers No. 95. University of Utah, Salt Lake City.

Cutler, Hugh C., and Winton Meyer
1965 Corn and Cucurbits from Wetherill Mesa. In *Contributions of the Wetherill Mesa Archaeological Project*, edited by Bernard S. Katz, pp. 136–152. Memoirs of the Society for American Archaeology No. 19. University of Utah, Salt Lake City.

Dalley, Gardiner F.
1970 Artifacts of Wood. In *Hogup Cave*, edited by C. Melvin Aikens, pp. 153–184. Anthropological Papers No. 93. University of Utah, Salt Lake City.

1976 *Swallow Shelter and Associated Sites*. Anthropological Papers No. 96. University of Utah, Salt Lake City.

Davis, Alan C., and Gerald A. Smith
1981 *Newberry Cave*. San Bernardino County Museum Association. Redlands, California.

Deegan, Ann Cordy
1996 Anasazi Square Toe-Square Heel twined Sandals: Construction and Cultural Attributes. *Kiva* 62(1):27–44.

Dellenbaugh, Frederick S.
1908 *A Canyon Voyage: The Narrative of the Second Powell Expedition Down the Green-Colorado River from Wyoming, and the Explorations on Land, in the Years 1871 and 1872*. Putnam, New York.

Dick, Herbert W.
1965 *Bat Cave*. School of American Research Monograph No. 27. Santa Fe, New Mexico.

Fairley, Helen C.
1989 Prehistory. In *Men, Models, and Management: An Overview of the Archaeology of the Arizona Strip and the Management of its Cultural Resources*, by Jeffrey H. Altschul and Helen C. Fairley, pp. 85–152. Report prepared for the Bureau of Land Management by Statistical

Research, Plateau Archaeology, and Dames and Moore, Inc. Phoenix, Arizona.

Fewkes, Jesse W.
1911 *Antiquities of the Mesa Verde National Park, Cliff Palace*. Bureau of American Ethnology Bulletin 51. Smithsonian Institution, Washington, D.C.

Fisher, Jacob L.
2009 Antelope Cave Unmodified Vertebrate Faunal Remains. Ms. on file, Keith L Johnson, Chico, California.

Fisher, Jacob L., Joel C. Janetski, and Keith L. Johnson
2013 Variability in Far Western Puebloan Subsistence Strategies: The View from the Uinkaret Plateau, Northwest Arizona. *Journal of Arizona Archaeology* 2(2):140–162.

Fisher, Jacob L., and Keith L Johnson
2014 Culinary Processing of Jackrabbits at Antelope Cave, Arizona. *Kiva* 79(3):307–333.

Fowler, Don D., David B. Madsen, and Eugene M. Hattori
1973 *Prehistory of Southeastern Nevada*. Desert Research Institute Publications in the Social Sciences No. 6. Reno, Nevada.

Fugassa, Martin H., Karl J. Reinhard, Keith L. Johnson, Scott L. Gardner, Monica Vieira, and Adauto Araujo
2011 Parasitism of Prehistoric Humans and Animals from Antelope Cave, Mojave County, Northwest Arizona. *Journal of Parasitology* 97(5):862–867.

Fulton, William S.
1941 *A Ceremonial Cave in the Winchester Mountains, Arizona*. The Amerind Foundation Publications No. 2. Dragoon, Arizona.

Geib, Phil R.
2011 *Foragers and Farmers of the Northern Kayenta Region: Excavations along the Navajo Mountain Road*. University of Utah Press, Salt Lake City.

Geib, Phil R., Nancy Coulam, Victoria H. Clark, and Kelly A. Hays-Gilpin
2007 Atlatl Rock Cave. In *Prehistory of the Northern Kayenta Anasazi Region: Archaeological Excavations Along the Navajo Mountain Road, Vol. II, Archaic Site Descriptions*, edited and assembled by Phil R. Geib, Kimberly Spurr, and Jim Collette, pp. II.2.1-II.2.50. Navajo Nation Archaeology Department Report No. 02-48. Northern Arizona University Office, Flagstaff, Arizona.

Geib, Phil R., and M. R. Robins
2003 The Desha Caves: Radiocarbon Dating and Coprolite Analysis. *Utah Archaeology* 16:81–94.

Geib, Phil R., and Kimberly Spurr
2000 The Basketmaker II-III Transition on the Rainbow Plateau. In *Foundations of Anasazi Culture: The Basketmaker-Pueblo Transition*, edited by Paul F. Reed, pp. 175-–229. University of Utah Press, Salt Lake City.

Gourley, Dale R.
2018 Ornaments and Related Objects. In *The Jackson Flat Reservoir Archaeological Project*, compiled by Heidi Roberts, Vol. 7(4) pp. 4–40. HRA Conservation Archaeology Report No. 09-12. Cedar City, Utah.

Grosscup, Gordon L.
1960 *The Culture History of Lovelock Cave*, Nevada. Reports of the University of California Archaeological Survey No. 52. Berkeley, California.

Guernsey, Samuel James
1931 *Explorations in Northeastern Arizona: Report on the Archaeological Fieldwork of 1920–1923*. Papers of the Peabody Museum of American Archaeology and Ethnology, Harvard University Vol. XII, No. 1. Cambridge.

Guernsey, Samuel James, and Alfred Vincent Kidder
1921 *Basket-Maker Caves of Northeastern Arizona: Report on the Explorations, 1916–17*. Papers of the Peabody Museum of American Archaeology and Ethnology, Harvard University Vol. VIII, No. 2. Cambridge.

Haarklau, L., L. Johnson, and D. L. Wagner
2005 *Fingerprints in the Great Basin: The Nellis Air Force Base Regional Obsidian Sourcing Study*. US Army Corps of Engineers, Fort Worth District, Fort Worth, Texas.

Haas, William Randall, Jr.
2006 Social Implications of Basketmaker II Cordage Design Distribution. *Kiva* 71(3):275–298.

Hall, Robert L., and Arthur E. Dennis
1986 Cultivated and Gathered Plant Foods. In *Archaeological Investigations at Antelope House*, by Don P. Morris, pp. 110–141. National Park

Service. U.S. Department of the Interior, Washington, D.C.

Hanes, Richard C.
1977 *Lithic Tools of the Dirty Shame Rockshelter: Typology and Distribution*. Tebiwa 6.

Haury, Emil W.
1945 *Painted Cave, Northeastern Arizona*. The Amerind Foundation, Dragoon, Arizona.

1950 *The Stratigraphy and Archaeology of Ventana Cave*. Arizona. University of Arizona Press, Tucson.

Hays-Gilpin, Kelley Ann, Ann Cordy Deegan, and Elizabeth Ann Morris
1998 *Prehistoric Sandals from Northeastern Arizona: The Earl H. Morris and Ann Axtell Morris Research*. Anthropological Papers Number 62. University of Arizona, Tucson.

Heizer, Robert F., and Martin A. Baumhoff
1961 The Archaeology of Wagon Jack Shelter. *Anthropological Records* 20(4):119–138. University of California, Berkeley.

Hildebrandt, William R., and Jerome H. King
2012 Distinguishing Between Darts and Arrows in the Archaeological Record: Implications for Technological Change in the American West. *American Antiquity* 77(4):789–799.

Hoffmeister, Donald F.
1986 *Mammals of Arizona*. University of Arizona Press and Arizona Fish and Game Department, Tucson.

Holmer, Richard N.
1980 Chipped Stone Projectile Points. In *Cowboy Cave*, edited by Jesse D. Jennings, pp. 31–38. Anthropological Papers No. 104. University of Utah, Salt Lake City.

Hovezak, Mark, and Phil R. Geib
2002 Wood and Fiber Artifacts. In *Bighorn Cave: Test Excavation of a Stratified Dry Shelter, Mohave County, Arizona*, edited by Phil R. Geib and Donald R. Keller, pp. 107–133. Bilby Research Center Occasional Papers No. 1. Northern Arizona University, Flagstaff.

Hrdlička, Aleš
1935 The Pueblos with Comparative Data on the Bulk of the Tribes of the Southwest and Northern Mexico. *American Journal of Physical Anthropology* 20(3):235–460.

Janetski, Joel C.
1980 Wood and Reed Artifacts. In *Cowboy Cave*, edited by Jesse D. Jennings, pp. 75–95. Anthropological Papers No. 104. University of Utah, Salt Lake City.

2017 Late Archaic to Early Puebloan Occupation on the Arizona Strip, Northwestern Arizona: A View from Rock Canyon Shelter. *Kiva* 83(2):203–242.

2018 Flaked Stone Analysis. In *The Jackson Flat Reservoir Archaeological Project*, compiled by Heidi Roberts, Vol. 7, chapter 1. HRA Conservation Archaeology Report No. 09-12. Cedar City, Utah.

Janetski, Joel C., and James D. Wilde
1989 A Preliminary Report of Archaeological Excavations at Antelope Cave and Rock Canyon Shelter, Northwestern Arizona. *Utah Archaeology* 2(1):88–106.

Janetski, Joel C., Cady B. Jardine, and Christopher N. Watkins
2011 Interaction and Exchange in Fremont Society. In *Perspectives on Prehistoric Trade and Exchange in California and the Great Basin*, edited by Richard E. Hughes, pp. 22–54. University of Utah Press, Salt Lake City.

Janetski, Joel C., Deborah E. Newman, and James D. Wilde
2013 *A Report of Archaeological Excavations at Antelope Cave and Rock Canyon Shelter, Northwestern Arizona*. Occasional Papers No. 19. Museum of Peoples and Cultures, Brigham Young University, Provo, Utah.

Jennings, Jesse D.
1957 *Danger Cave*. Anthropological Papers No. 27. University of Utah, Salt Lake City.

Johnson, Keith L, and David M. Pendergast
1960 Archaeological Exploration of Antelope Cave, Arizona. Ms. on file Department of Anthropology and Sociology, University of California, Los Angeles.

Johnson, Keith L, Karl J. Reinhard, Luciana Sianto, Adauto Araujo, Scott L. Gardner, and John Janovy, Jr.
2008 A Tick from a Prehistoric Arizona Coprolite.

Journal of Parasitology 94(1):296–298.

Jones, Anne Trinkle
1986 *A Cross Section of Grand Canyon Archaeology: Excavation at Five Sites Along the Colorado River*. Western Archaeological and Conservation Center Publications in Anthropology No. 28. Tucson.

Jones, Volney H., and Robert L. Fonner
1954 Plant Materials from Sites in the Durango and La Plata Areas, Colorado. In *Basket Maker II Sites Near Durango, Colorado*, edited by Earl H. Morris and Robert F. Burgh, pp. 106–115. Carnegie Institution of Washington Publication 604. Washington, D.C.

Judd, Neil M.
1926 *Archaeological Observations North of the Rio Colorado*. Bureau of American Ethnology, Bulletin No. 82. Washington, D.C.

1930 *The Excavation and Repair of Betatakin*. Proceedings of the United States National Museum, Vol. 77, Art. 5. Smithsonian Institution, Washington D.C.

Kankainen, Kathy (editor)
1995 *Treading in the Past: Sandals of the Anasazi*. Utah Museum of Natural History and University of Utah Press, Salt Lake City.

Kaplan, Lawrence
1956 The Cultivated Beans of the Prehistoric Southwest. *Annals of the Missouri Botanical Garden* 43:189–251.

Kidder, Alfred V., and Samuel J. Guernsey
1919 *Archaeological Explorations in Northeastern Arizona*. Bureau of American Ethnology, Bulletin 65. Washington, D.C.

Lambert, Marjorie F., and J. Richard Ambler
1961 *A Survey and Excavation of Caves in Hidalgo County, New Mexico*. The School of American Research, Monograph No. 25. Santa Fe, New Mexico.

Lamphere, Louise
1983 Southwestern Ceremonialism. In *Southwest. Handbook of North American Indians*, Vol. 10, edited by Alfonso Ortiz pp. 743–763. Smithsonian Institution, Washington, D. C.

Lindsay, Alexander, Jr., J. Richard Ambler, Mary Anne Stein, and Philip M. Hobler
1968 *Survey and Excavations North and East of Navajo Mountain, Utah, 1959–1962*. Bulletin No. 45. Museum of Northern Arizona, Flagstaff.

Lyneis, Margaret M.
1995 The Virgin Anasazi, Far Western Puebloans. *Journal of World Prehistory* 9:199–241.

Magers, Pamela C.
1986 Weaving at Antelope House. In *Archaeological Investigations at Antelope House*, edited by Don P. Morris, pp. 224–276. National Park Service. U.S. Department of the Interior, Washington, D.C.

Martin, Paul S., John B. Rinaldo, and Elaine Bluhm
1954 Caves of the Reserve Area. *Fieldiana: Anthropology* Vol. 42. Chicago Natural History Museum, Chicago, Illinois.

Martin, Paul S., John B. Rinaldo, Elaine Bluhm, Hugh C. Cutler, and Roger Grange, Jr.
1952 Mogollon Cultural Continuity and Change: The Stratigraphic Analysis of Tularosa and Cordova Caves. *Fieldiana: Anthropology* Vol. 40. Chicago Natural History Museum, Chicago, Illinois.

Matson, Richard G.
1991 *The Origins of Southwestern Agriculture*. University of Arizona Press, Tucson.

2006 What is Basketmaker II? *Kiva* 72(2):149–165.

McFadden, Douglas A.
2016 *Formative Chronology and Site Distribution on the Grand Staircase-Escalante National Monument: A Research Reference*. Utah Cultural Resource Series No. 28. Grand Staircase-Escalante National Monument Special Publication No. 4. Bureau of Land Management, Salt Lake City, Utah.

Meighan, Clement W., Norman E. Coles, Frank D. Davis, Geraldine M. Greenwood, William M. Harrison, and E. Heath MacBain
1956 Archaeological Excavations in Iron County, Utah. Anthropological Papers No. 25. University of Utah, Salt Lake City.

Minnis, Paul E.
1989 Prehistoric Diet in the Northern Southwest: Macroplant Remains from the Four Corners Feces. *American Antiquity* 54(3):543–563.

Morris, Earl H., and Robert F. Burgh
1954 *Basket Maker II Sites Near Durango, Colorado*. Carnegie Institution of Washington Publication 604. Washington, D.C.

Morris, Elizabeth Ann
1980 *Basketmaker Caves in the Prayer Rock District, Northeastern Arizona*. Anthropological Papers No. 35. University of Arizona, Tucson.

Nielsen, Asa
1998 *Excavation/Mitigation Report on Three Sites Near Hildale, Utah, 42WS2195, 42WS2196, AZ B:1:35 (BLM) (Reservoir Site)*. Baseline Data, Orem, Utah.

Nusbaum, Jesse L.
1922 *A Basket-Maker Cave in Kane County, Utah*. Indian Notes and Monographs, Miscellaneous Series No. 29. Museum of the American Indian, Heye Foundation. New York.

Osborne, Carolyn M.
2004 *The Wetherill Collections and Perishable Items from Mesa Verde*. Lulu Press, Inc. Morrisville, North Carolina.

Pendleton, Lorann S. A.
1985 Material Culture: Artifacts of Stone. In *The Archaeology of Hidden Cave, Nevada*, edited by David Hurt Thomas, pp. 183–218. Anthropological Papers of the American Museum of Natural History Vol. 61. New York.

Reinhard, Karl J., Keith L Johnson, Sara LeRoy-Toren, Kyle Wiesman, Isabel Teixeria-Santos, and Monica Vieira
2012 Understanding the Pathoecological Relationship between Ancient Diet and Modern Diabetes through Coprolite Analysis: A Case Example from Antelope Cave, Mojave County, Arizona. *Current Anthropology* 53(4):506–512, Supplements A, B, C.

Roberts, Heidi
2018 *The Jackson Flat Reservoir Archaeological Project*. HRA Conservation Archaeology Report No. 09-12. Cedar City, Utah.

Roberts, Heidi, and Richard V. N. Ahlstrom
2018 Synthesis. In *The Jackson Flat Reservoir Archaeological Project*, edited by Heidi Roberts, Vol. 9. HRA Conservation Archaeology Report No. 09-12. Cedar City, Utah.

Schlanger, Sarah H.
1992 Recognizing Persistent Places in Anasazi Settlement Systems. In *Space, Time, and Archaeological Landscapes*, edited by J. Rossignol and L. Wandsnider, pp. 91–112. Plenum Press, New York.

Sliva, R. Jane
2015 *Projectile Points of the Early Agricultural Southwest: Typology, Migration, and Social Dynamics from the Sonoran Desert to the Colorado Plateau*. Archaeology Southwest. Tucson, Arizona.

Smith, Geoffrey M., Pat Barker, Eugene M. Hattori, Anan Raymond, and Ted Goebel
2013 Points in Time: Direct Radiocarbon Dates on Great Basin Projectile Points. *American Antiquity* 78(3):580–594.

Taylor, Walter W.
2003 *Sandals from Coahuila Caves*. Studies in Pre-Columbian Art & Archaeology Number 35. Dumbarton Oaks Research Library and Collection, Washington D.C.

Thomas, David Hurst
1981 How to Classify the Projectile Points from Monitor Valley, Nevada. *Journal of California and Great Basin Anthropology* 3(1):7–43.

1985 *The Archaeology of Hidden Cave, Nevada*. Anthropological Papers of the American Museum of Natural History Vol. 61. New York.

Thompson, Richard A.
1970 *Prehistoric Settlement in the Grand Canyon National Monument*. Southern Utah State College Faculty Research Series No. 1. Cedar City, Utah.

Thompson, Richard A., and Georgia Beth Thompson
1974 A Preliminary Report of Excavations in the Grand Canyon National Monument. Sites: GC670, GC 761, and GC 663. Ms. on file, Grand Canyon National Park, Grand Canyon and Southern Utah State College, Cedar City.

Weder, Dennis G.
1980 Lithic Artifacts and Debitage. In *Cowboy Cave*, edited by Jesse D. Jennings, pp. 39–48. Anthropological Papers No. 104. University of Utah, Salt Lake City.

Wheeler, Sidney M.
1973 *The Archaeology of Etna Cave, Lincoln*

County, Nevada. Desert Research Institute Publications in the Social Sciences No. 7. Reno, Nevada.

Webster, Laurie D.
2012 The Perishable Side of Early Pueblo Style and Identity: Textiles, Sandals, and Baskets. In *Crucible of Pueblos: The Early Pueblo Period in the Northern Southwest*, edited by Richard H. Wilshusen, Gregson Schachner, and James R. Allison, pp. 159–184. Monograph 71, Cotsen Institute of Archaeology Press. University of California, Los Angeles.

2018 Analysis of Basketmaker Sandals from Antelope Cave. Documents in possession of Keith L Johnson, Chico, California.

Winslow, Diane L.
2009 Mitigation Black Dog Mesa Archaeological Complex, Volume III- Pithouse Excavations, Locus 4 and Volume IV- Conclusions and Research Questions Addressed. Harry Reid Center for Environmental Studies, Marjorie Barrick Museum of Natural History. University of Nevada, Las Vegas.

Winslow, Diane L., and Lynda M. Blair
2003 *Mitigation Black Dog Mesa Archaeological Complex, Vol. II, Black Dog Cave*. Harry Reid Center for Environmental Studies, Marjorie Barrick Museum of Natural History. University of Nevada, Las Vegas.

Yoder, David T.
2010 Plain-Weave Sandals from Antelope Cave, Arizona. *Kiva* 75(3):327–350.

2013 Antelope Cave Sandals. In *A Report of Archaeological Excavations at Antelope Cave and Rock Canyon Shelter, Northwestern Arizona*, edited by Joel C. Janetski, Deborah E. Newman, and James D. Wilde, pp. 103–120. Occasional Papers No. 19. Museum of Peoples and Cultures, Brigham Young University, Provo, Utah.

THE BIRD-SNAKE MOTIF AS A METAPHOR FOR RAIN

Kris Powell

The bird-snake motif has been identified on a variety of artifact types throughout the southern Southwest during the Hohokam Preclassic and Mimbres Late Pithouse periods. The purpose of the paper is to demonstrate that the bird-snake motif is a metaphor for rain. Ethnographic accounts from the Akimel and Tohono O'Odham provide data on the significance of rain and the association of songs, stories, and ceremonial imagery with water birds and snakes. Furthermore, it is postulated that prehistoric communities had similar ceremonies and that a rain ideology featured prominently in the Hohokam Ballcourt Society.

Rain is a matter of life and death in the desert. Images of spirals, often associated with wind and rain, are more numerous in the Hohokam rock art than anywhere else in the Southwest (Schaafsma 1980:90). Shell bracelets depicting frog, snake, and bird iconography are associated with water-agricultural-fertility ideology (Bayman 2002). Turquoise may also be associated with the cyclic movement of water and the Flower World (Russell et al. 2018). The paleobotanical remains of tobacco, often associated with rain and clouds, were noted at several archaeological sites – AZ U:15:84(ASM), Frogtown, Smiley's Well, Las Fosas, Las Colinas, and Pueblo Grande (Bohrer 1991; Bostwick et al. 2010; Underhill et al. 1979). A Mesoamerican rain deity has been suggested to be depicted in abstracted Hohokam imagery as painted bird and snake images on pottery and as plumed serpents in rock art (Bostwick et al. 2010). All of these artifacts and features demonstrate that rain was a focal component of concern for prehistoric inhabitants of the southern Southwest.

Researchers have examined prehistoric designs on artifacts to identify activities or symbols that may relate to a cultural belief system or worldview (Adams 1991; Crown 1994; Gilman et al. 2014; Hay-Gilpin and Hill 1999; Moulard 1984; Thompson et al. 2014; and Wallace 2014). Through the incorporation of ethnographic examples, this paper develops the argument that the bird-snake motif is a metaphor for rain. The paper begins with a discussion on the application of metaphor for studying ideology and introduces the use of O'odham ethnography to examine Hohokam artifacts. The data on the bird-snake motif are offered with reference to chronology, distribution, and motif variation. After the archaeological data are presented, the paper summarizes an ethnographic review of rain as it relates to water birds and snakes. The paper concludes with a discussion on the bird-snake motif as a metaphor for rain and implications for future studies.

METAPHOR IN ARCHAEOLOGY

The premise of this study is that the bird-snake motif is a metaphor that represents an ideology associated with rain. A metaphor involves the transfer of one term from one system of meaning to another term. Metaphors are inherent within all languages and are generally specific to a particular cultural group (Tilley 1999). Although the use of metaphors is characterized as a type of language structure, they are representations of the conceptual system (Lakoff and Johnson 1980). The choice of words and phrases are constrained by the underlying conceptual system that may not even be conscious (Lakoff and Johnson 1980). By examining the word choices in a language, it is possible to identify metaphorical links that are significant for a particular community.

The Hohokam did not possess a written language that can be investigated, yet they did communicate through artistic expressions on prehistoric artifacts. It is assumed that the descendent communities (O'Odham) would have retained similar conceptual systems as their ancestors. Historically, there has been much debate on the relationship between the Hohokam and the O'odham (Ezell 1963; Haury 1976; McClelland 2015). However, large scale archaeological studies on the Gila River Indian Community have firmly established a continuous relationship between prehistoric and historic populations in this area (Loendorf and Lewis 2017). The descendent relationship between the prehistoric and historic communities is a central tenant of the ethnographic evidence

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used to support the argument that the bird-snake motif is a metaphor for rain.

By studying O'Odham concepts concerning water bird and rattlesnake categorization, the cultural significance of different folk species can be recognized (Rea 1998, 2007). Combining these terms with stories, songs and rituals, can provide insight into the underlying conceptual systems associated with some of the specific bird-snake motif imagery.

THE HOHOKAM DURING THE PRECLASSIC PERIOD

The Hohokam primarily occupied the Gila and Salt River valleys in Phoenix and the Santa Cruz River valley and surrounding areas in Tucson (Crown 1991; Doelle and Wallace 1991). However, it was during the period between AD 800 and AD 1150 that the Hohokam expanded into areas not previously occupied by them (Doyle 1980; Wilcox and Sternberg 1983). The cultural traits that distinguish the Hohokam during this time include red-on-buff pottery, carved and etched shell artifacts, palettes, cremations, plazas, irrigation canals, and ballcourts (Haury 1976).

Due to the diversity of environmental habitats, the Hohokam adapted their subsistence practices to the localized conditions with irrigation farming near rivers, ak-chin farming on alluvial fans, and floodwater farming (Fish 1989). Irrigation studies have been completed along the Middle Gila River (Woodson 2010), the Great Bend of the Gila (Wright et al. 2015); Salt River (Graybill 1989; Howard and Huckleberry 1991; Nials and Gregory 1989; Nials et al. 2004; Nicholas and Feinman 1989), Santa Cruz (Huckleberry 2008), lower San Pedro (Wallace and Doelle 2001), and the Verde (Ciolek-Torrello 1997). Villagers who lived away from the river focused on ak-chin or dry farming techniques for their agriculture and supplemented their agricultural produce with non-cultivated native plant foods (Gasser and Kwiatkowski 1991).

Consequences of each of these subsistence strategies differed. For the settled villages, water was generally abundant, but work was required to create and sustain the irrigation canals needed to bring moisture to the fields. Irrigation infrastructure is highly susceptible to the unpredictability of rivers through floods, droughts, and silt deposition events (Ingram 2008; Nials and Gregory 1989; Waters and Ravesloot 2001). Additionally, for those villages with a more settled agricultural life, the threat of wandering bands of hunter-gatherers necessitated skilled warriors (Rice 2001). Villages focused on ak-chin farming were dependent on adequate rainfall for their agriculture and wild plant foods. Stress due to a lack of rainfall would need to be mediated through social risk avoidance strategies, such as social alliances (Rautman 1993). Strawhacker et al. (2020) demonstrated that the Salinas farmers who relied on rainfed farming depended on social networks in times of rainfall scarcity to a much greater degree than the Cibola farmers who could access reliable water from a nearby river. It is probable that this may have been a similar situation with the dry farming activities of some of the Hohokam villages.

Hohokam Ballcourts

Hohokam ballcourts occur throughout central and southern Arizona beginning in the Gila Butte phase of the Preclassic Period (Wilcox and Sternberg 1983). Ballcourts ranged across southern Arizona from the Gila Bend area to the extreme southwestern corner of New Mexico, extending to the Verde and Oak Creek Valleys and northward near Prescott and Flagstaff along the Little Colorado drainage, encompassing the Hohokam regional system (Wilcox and Sternberg 1983). The margins of the ballcourt distribution extend into non-Hohokam lands inhabited by the Sinagua and Cohonina (Wilcox et al. 1996) as well as the Mimbres. As is representative of the linear nature of the Hohokam settlement pattern, the ballcourts also follow major river valleys (Abbott et al. 2007; Gregory 1991). A total of 236 ballcourts have been identified (Wallace 2014:Appendix D). While most major sites during this time have at least one ballcourt – there are approximately 36 villages that have more than one ballcourt (Wallace 2014:Appendix D). Interestingly, a large proportion of these villages with multiple ballcourts are located in the Gila Bend area (Wilcox and Sternberg 1983).

Public architecture is often interpreted as serving an integrative function for sites within larger networks. Wilcox and Sternberg (1983) argue that the ballcourts represented the operation and evolution of a ceremonial exchange system linking the Hohokam settlements. Similarly, Abbott et al. (2007) demonstrated that ballcourts were marketplaces where goods were distributed throughout the region. One aspect of the ceremonial nature of the ballcourts is that the rituals were communal and inclusive of the whole village and/or multiple villages (Wilcox and Sternberg 1983).

Preclassic Hohokam Religion – the Ballcourt Society

The bird-snake motif may have been part of the cosmology and symbology of the Hohokam Ballcourt Society, a revitalization movement associated with the Preclassic period (Wallace 2014). Wallace argues that it was the social inclusion of ritual leadership that bound the communities. Wallace further postulates that the ideology that connects the villages along the Middle Gila River was in response to environmental stresses. It is therefore appropriate that the other symbols associated with the Ballcourt Society also include weather-related items; such as rainfall and water availability, the winter solstice, and solar eclipses (Wallace 2014). Artifacts associated with the promotion of these concepts include micaceous tempered ceramics and schist palettes that may visually represent water, toad-snake motifs that are associated with summer rains, and bighorn sheep horn caches, which are often associated with tinajas in western Arizona. Wallace (2014:479) made a comparison between the toad-snake and the bird-snake motif and suggested the bird-snake motif was "wholly associated with the identity and ideology of the Ballcourt Society," whereas the toad-snake motif, being more limited in distribution, was probably associated with more specific rituals.

THE BIRD-SNAKE MOTIF

The bird-snake motif occurs in various forms across a suite of artifact classes. The bird-snake motif is best described as a bird holding a snake in its beak. The bird image is associated with water birds due to its long "s" shaped necks, long beaks, and long legs. The snake image generally appears to be a rattlesnake.

Previous Investigations of the Bird-Snake Motif

The bird-snake motif has not been intensively investigated previously, but has been briefly explored in the literature. It was first described in detail by Haury (1976:232-233,314) in relationship to the depiction of the bird-snake motif on ceramic, bone, and shell artifacts from Snaketown. Haury suggested it was a Mesoamerican symbol that was a disguise for Quetzalcoatl (Haury 1976:319, Figure 17.3). Wallace (2007) addressed this motif in a discussion concerning birds and snakes in Hohokam art. As it related to the bird-snake motif, Wallace (2007:7) noted that the combination, although visible in nature, probably represented a component of Hohokam mythology. Based on rock art and known traits of snakes [shedding their skin], Wallace postulated that snakes may symbolize power, death, birth and renewal. With their ability to fly, birds may symbolize the spirit world and associated rituals. Wallace (2007) speculated that together, it may be possible that the bird-snake motif represented ascendancy over the underworld, although there is no way to know for sure.

Archaeological Evidence of the Bird-Snake Motif

The bird-snake motif occurs on ceramic vessels, shell pendants and bracelets, bone rings and hairpins, stone palettes, and rock art. A total of 137 artifacts have been identified with this motif. There are three variations of the bird-snake motif which describe the different ways in which the bird is engaging the snake. These subtle divergences appear to be culturally relevant. Each variation adds another layer in its metaphorical meaning. Each of these variations is described below.

Bird Holding the Head of a Snake in its Beak

This variation is represented on shell bracelets, bone and shell rings, a bone hairpin, stone palettes, and rock art (Figure 1, Table 1). These depictions include both naturalistic and stylized versions of the motif, which ranges from the Gila Butte phase to the Classic period (see Table 1).

The shell bracelets demonstrate this naturalistic version of the motif with either one bird or two birds back to back, both with the head of a snake in its beak (see Figure 1a; Bradfield 1931; Gladwin et al. 1975; Jernigan 1978; Wallace 2014). Another version of the naturalistic shell bracelets includes two birds, back to back, holding one snake, with one bird holding the head and the other holding the tail (see Figure 1b; Jacobs 2010). Hohokam artists used the crenulations on the shell to incorporate the snake's body into the bracelet. The bone and shell rings mirror the shell bracelets with their naturalistic design of either one or two birds biting the head of a snake (Gladwin et al. 1975; Jacobs 2010). Similarly, the bone hairpin features two birds perched on top intertwined snakes with one holding the head of a snake in its beak while the other holds the tail in its beak (see Figure 1c; Woodward 1931; Jernigan 1978). The rock art image consists of one bird holding the head of one snake (see Figure 1d; Bostwick 2002).

The carved stone palettes are rectangular in shape and sometimes have sculptured edges, a trait which is most prominent during the Santa Cruz phase (see Figure 1e; Haury 1976; White 2004). The bird-snake motif is depicted as a bird biting the head of a straight snake. Alternatively, there is a variation of the bird biting the tail of the snake. These end sculptures are very similar to the zoomorphic shell pendent observed at Los Muertos (Haury 1945).

The stylized version of the carved shell bracelets and rings include the snake as a wavy line and has reduced the bird to be depicted as an "M" (see Figure 1f; Gladwin et al. 1975; Jernigan 1978). Both the naturalistic and the stylized versions of the shell bracelets and rings were contemporary, making any variation based on resource availability of stylistic replacement unlikely (Gladwin et al. 1975).

Bird Holding the Neck of the Snake in its Beak

This variation of the bird-snake motif features the bird holding the neck of the snake in its beak (Figure 2, Table 2). The artifacts that display this variation of the

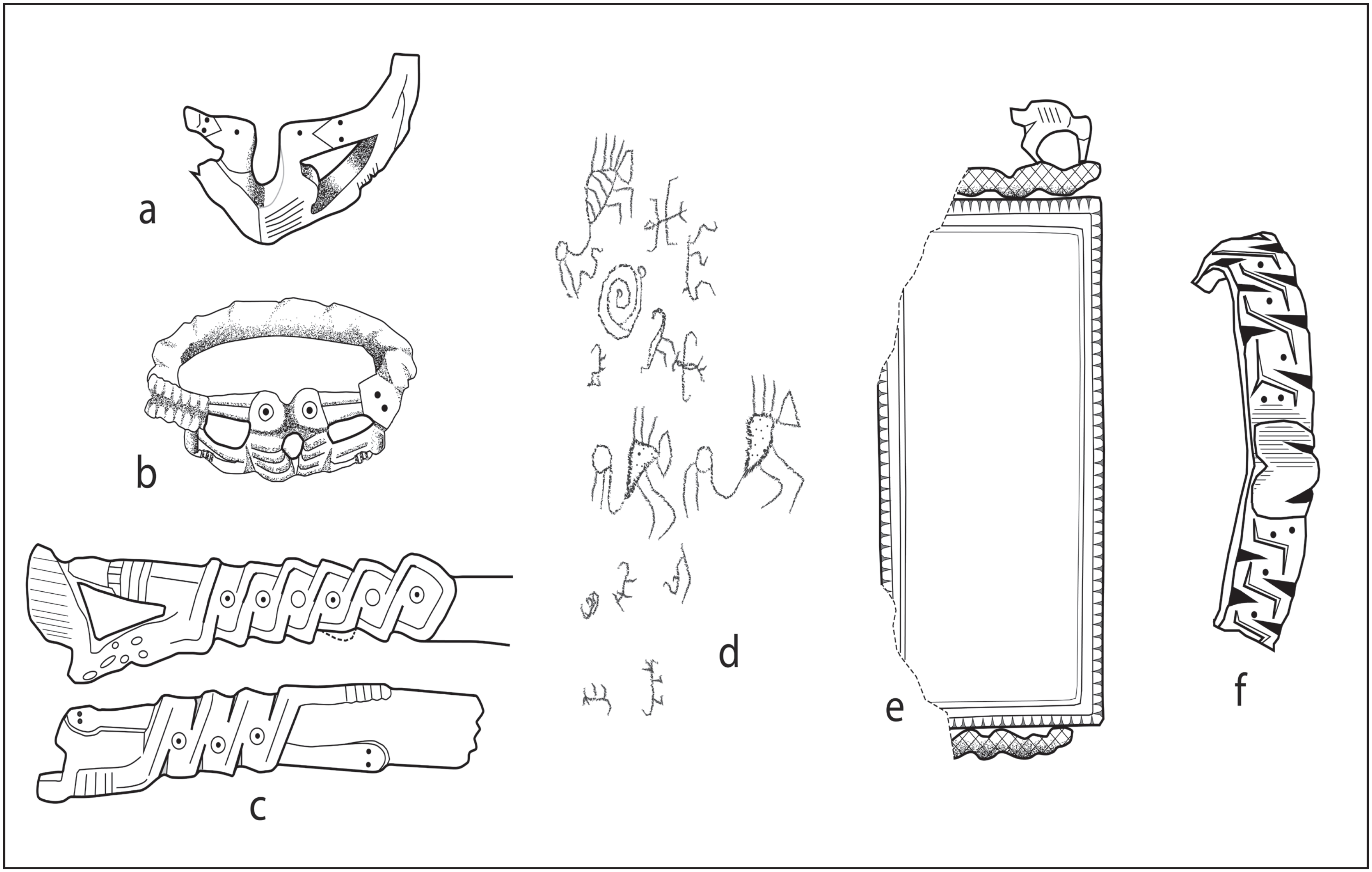

FIGURE 1. Bird holding the head of a snake variation of the bird-snake motif; a) naturalistic carved shell bracelet from Sabino Canyon (adapted from Wallace 2014:480), b) naturalistic carved shell bracelet from Pozos de Sonoqui (adapted from Jacobs 2010:213),c) carved bone hairpin from Grewe (adapted from Jernigan 1978) d) rock art from South Mountain (adapted from Bostwick 2002:91), e) carved stone palette from Snaketown (adapted from White 2004:CD appendix), "M" style carved shell bracelet from Snaketown. Illustrations by Shearon Vaughn. (Adapted from Gladwin et al. 1975:143)

Table 1. Artifacts Displaying a Bird-Snake Variation of the Bird Holding the Head of a Snake in its Beak

Site Name	Artifact Type	Material	Temporal Association	Number of Artifacts	Reference
			Northern Arizona		
Flagstaff*	Palette	Stone	Santa Cruz phase	1	White 2004
Upper Verde*	Palette	Stone	Santa Cruz phase	1	White 2004
Lower Verde*	Palette	Stone	Santa Cruz phase	1	White 2004
			Central Arizona		
Tonto Basin*	Palette	Stone	Santa Cruz phase	1	White 2004
			Gila River – Gila Bend		
Gila Bend*	Palette	Stone	Santa Cruz phase	1	White 2004
Gatlin Site	Palette	Stone	Santa Cruz phase	1	White 2004
12-Mile Site*	Palette	Stone	Santa Cruz phase	1	White 2004
Homestead*	Palette	Stone	Santa Cruz phase	1	White 2004
			Salt River		
Los Muertos	Palette	Stone	Santa Cruz phase	1	White 2004
Casa Buena	Palette	Stone	Santa Cruz phase	1	White 2004
Los Hornos	Palette	Stone	Santa Cruz phase	1	White 2004
Pueblo Grande	Palette	Stone	Santa Cruz phase	1	White 2004
Lower Salt*	Palette	Stone	Santa Cruz phase	1	White 2004
			Middle Gila River		
Snaketown	Palette	Stone	Santa Cruz phase	1	White 2004
Snaketown	Carved Ring	Bone	Sedentary period	11	Gladwin et al. 1975
Snaketown	Naturalistic Carved Bracelet	Shell	Colonial period	1	Gladwin et al. 1975
Snaketown	“M” Style Carved Bracelet	Shell	Gila Butte phase	1	Gladwin et al. 1975
Snaketown	“M” Style Carved Bracelet	Shell	Santa Cruz phase	3	Gladwin et al. 1975
Snaketown	“M” Style Carved Bracelet	Shell	Sacaton phase	6	Gladwin et al. 1975
Snaketown	“M” Style Carved Bracelet	Shell	Unplaced	5	Gladwin et al. 1975
Snaketown	“M” Style Carved ring	Shell	Sacaton phase	2	Gladwin et al. 1975
Snaketown	“M” Style Carved ring	Shell	Unplaced	4	Gladwin et al. 1975
Grewe	Palette	Stone	Santa Cruz phase	1	White 2004
Grewe	Naturalistic Carved Bracelet	Shell	Sedentary period	1	Jernigan 1978
Grewe	Carved Hairpin	Bone	Colonial Period	1	Woodward 1931; Jernigan 1978
Casa Grande	Palette	Stone	Santa Cruz phase	1	White 2004
Lower Gila*	Palette	Stone	Santa Cruz phase	1	White 2004
Buttes Dam	Palette	Stone	Santa Cruz phase	1	White 2004

continued

Table 1. Artifacts Displaying a Bird-Snake Variation of the Bird Holding the Head of a Snake in its Beak

Site Name	Artifact Type	Material	Temporal Association	Number of Artifacts	Reference
Queen Creek					
Sonoqui Pueblo	Carved Ring	Shell	Sacaton phase	1	Jacobs 2010
Queen Creek*	Palette	Stone	Santa Cruz phase	1	White 2004
Santa Cruz River and Tucson					
Hodges Ruin	Palette	Stone	Santa Cruz phase	1	White 2004
West Branch	Palette	Stone	Santa Cruz phase	1	White 2004
Julian Wash	Palette	Stone	Santa Cruz phase	1	White 2004
Tucson Basin*	Palette	Stone	Santa Cruz phase	1	White 2004
Nogales*	Palette	Stone	Santa Cruz phase	1	White 2004
Sabino Canyon	Naturalistic Carved Bracelet	Shell	Rincon phase	1	Wallace 2014
University Indian Ruin	"M" Style Carved Bracelet	Shell	Classic period	1	Jernigan 1978
Southeast Arizona					
Tres Alamos	Palette	Stone	Santa Cruz phase	1	White 2004
Safford*	Palette	Stone	Santa Cruz phase	1	White 2004
Southeast AZ*	Palette	Stone	Santa Cruz phase	1	White 2004
Dragoon*	Palette	Stone	Santa Cruz phase	1	White 2004
Mimbres Valley					
Cameron Creek	Naturalistic Carved Bracelet	Shell	Late Style II-Early Style III (Sedentary period)	2	Bradfield 1931
Mimbres*	Palette	Stone	Unknown	1	White 2004

*This is a location, not a specific site name

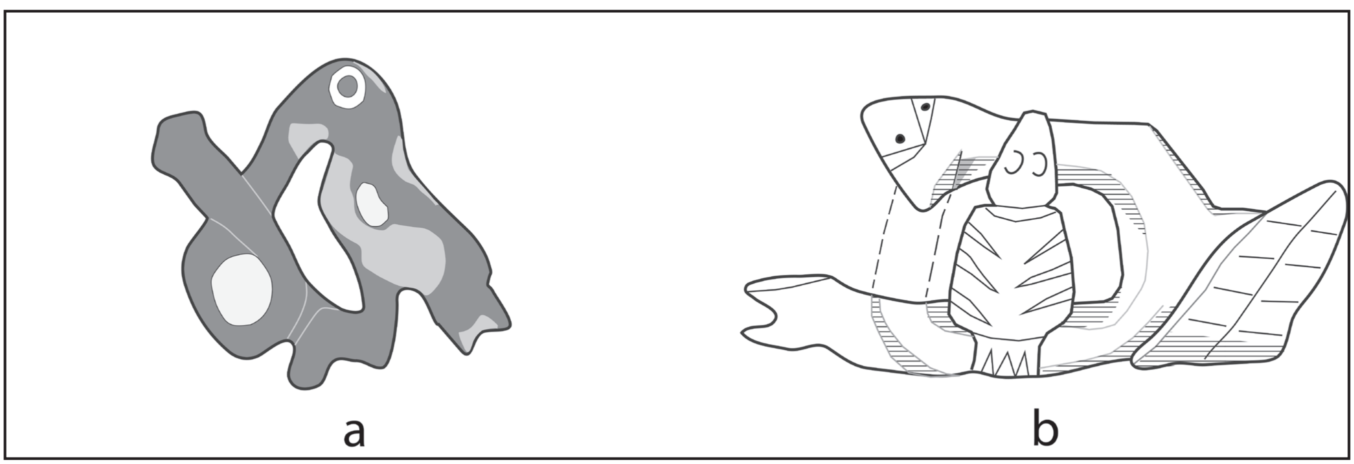

FIGURE 2. Bird holding the neck of the snake variation of the bird-snake motif; a) zoomorphic carved shell pendant from Citrus site (adapted from Wasley and Johnson 1965:103) and b) stylized feather carved shell bracelet from Hodges Ruin (adapted from Kelly 1978:119). Illustrations by Shearon Vaughn.

Table 2. Artifacts Displaying a Bird-Snake Variation of the Bird Holding the Neck of the Snake in its Beak

Site Name	Artifact Type	Material	Temporal Association	Number of Artifacts	Reference
			Salt River		
Los Muertos	Zoomorphoric Pendant	Shell	Classic	1	Haury 1945
AZ U:9:169(ASM)	Stylized Feather Carved Bracelet	Shell	Colonial	1	Powell and Boston 2004
			Middle Gila River		
Snaketown	Stylized Feather Carved Bracelet	Shell	Gila Butte Phase	1	Gladwin et al. 1975
Snaketown	Stylized Feather Carved Bracelet	Shell	Santa Cruz Phase	6	Gladwin et al. 1975
Snaketown	Stylized Feather Carved Bracelet	Shell	Sacaton Phase	3	Gladwin et al. 1975
Snaketown	Stylized Feather Carved Bracelet	Shell	Unknown	12	Gladwin et al. 1975
			Gila Bend - Gila River		
Citrus Site	Zoomorphic Pendants	Shell	Sedentary Period	9	Wasley and Johnson 1965
			San Pedro River		
Tres Alamos	Stylized Feather Carved Bracelet	Shell	Sedentary Period	1	Tuthill 1947
Gleeson*	Zoomorphic Pendant	Shell	Sedentary Period	1	Jernigan 1978; Fulton and Tuthill 2012
			Santa Cruz River - Tucson		
Hodges Ruin	Stylized Feather Carved Bracelet	Shell	Colonial-Sedentary Period	1	Kelly 1978
			Mimbres Valley		
NAN Ranch Ruin	Zoomorphic Pendants	Shell	Style III (Sedentary Period)	2	Cosgrove and Cosgrove 1932
Mimbres*	Stylized Feather Carved Bracelet	Shell	Style II (Sedentary Period)	1	Jernigan 1978

*Location and not a specific site name

bird-snake motif included zoomorphic shell pendants and stylized feather shell bracelets.

Two pendants were observed, one from Los Muertos and the other from Gleeson. The Los Muertos specimen consists of a bird bending down to hold the neck of a straight snake (Haury 1945); whereas the Gleeson specimen is of a bird holding the neck of a coiled snake (Jernigan 1978). The provenience of these specimens is unknown.

The remaining zoomorphic pendants are from two separate caches of almost identical pendants located several hundred miles apart. One cache is from the Citrus site in Gila Bend. In addition to approximately 70 carved shell pendants (only 9 display the bird-snake motif), the pit cache also contained a stone bowl, two large chucks of obsidian, several beads, and 235 projectile points (Wasley and Johnson 1965). The shell pendants identified in the cache include the bird-snake motif (see Figure 2a), "Charlie Chaplin" type human figures, "bird-eating-fish" pendants, reptiles, disc pendants, stylized birds, and zoomorphic depictions that were suggested to be cipactlis, the Aztec Deity that was part crocodilian, part fish, and part toad or frog. Although the entire assemblage was thoroughly burned in a similar fashion to a cremation, careful examination of the pit revealed no human remains (Wasley and Johnson 1965). It may be that these specimens were of special value and were ritually retired through burning as other similar examples have been identified in the Hohokam area (Bostwick et al. 2010).

The bird-snake motif from the Citrus site cache consists of a water bird biting the neck of a coiled snake (Wasley and Johnson 1965). Both left and right facing birds are included in the cache. Interestingly, on two specimens, the coiled portion of the snake was inlayed with turquoise and shell beads may have been used for the eyes.

The other cache of similar artifacts (e.g. "Charlie Chaplin" type human figures, geomorphic pendants, and beads) was identified at NAN Ranch Ruin in southwestern New Mexico. A total of two bird-snake motif pendants were identified from the cache that included both a left and a right facing bird biting the neck of a coiled snake (Cosgrove and Cosgrove 1932). Both of the pendants included shell beads for the eyes and turquoise inlay in the coils of the snake. The "Charlie Chaplin" type human figures were also observed at NAN Ranch Ruin. The pendants were part of a child's burial offerings.

This variation of the bird-snake motif also occurs on stylized shell bracelets. The Hohokam artists reduced the water bird image to a stylized feather with a head. This image is carved out of the umbo portion of the shell. The bird holds the neck of the snake in its beak with the rest of the snake forming the bracelet (see Figure 2b; Gladwin et al. 1975; Jernigan 1978; Kelly 1978; Powell and Boston 2004; and Tuthill 1947).

Multiple Birds Biting Snake or One Bird Biting Snake

This variation of the bird-snake motif features multiple birds biting a snake or one bird biting a snake (Figure 3). Unlike the other variations that focused on either the head or the neck of the snake, these depictions do not seem to be associated with a particular location on the snake. The birds attack the snake in many, seemingly random locations. This version of the motif is featured exclusively on ceramics. Ceramics provide an opportunity for a wider range of design variations as it is easier to paint than to carve. It also provides other images in the display that add additional context to the bird-snake motif (Table 3).

The Hohokam ceramic vessels include multiple birds biting one snake (see Figure 3a-c). Hohokam ceramic forms include bowls, plates, and a tripod vessel that range in date from late Gila Butte phase through the Sedentary period. The number of birds vary among vessels, ranging from two to 16. Although the snake is generally coiled, it is drawn as relatively straight on the tripod vessel. The birds are generally triangular, but are very clearly depicted as long-legged and long-billed water birds. On some of the vessels, the body of the Hohokam bird is hour-glass shaped (see Figure 3c). The snake bodies have various designs; solid, hatched, cross-hatched, and diamond-shaped. In addition, some snakes have dots in the center of their coils, which is similar to the turquoise inlay in the Citrus site pendants (Wasley

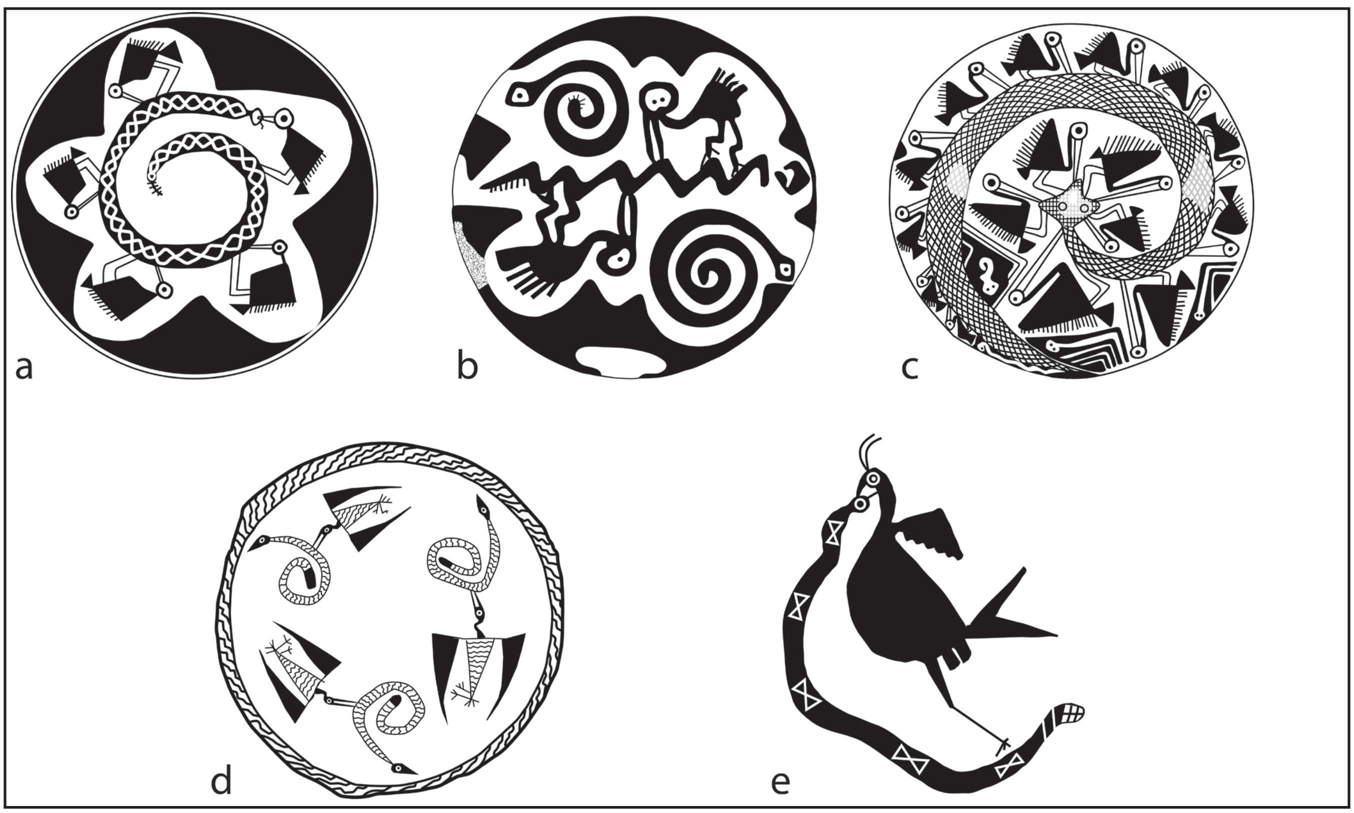

FIGURE 3. Multiple birds biting one snake or one bird biting one snake variation of the bird-snake motif; a) Sacaton red-on-buff bowl near Casa Grande (adapted from Wallace 2014:480), b) Middle Sacaton I red-on-buff tripod from Snaketown (adapted from Wallace 2014:480), c) Rillito red-on-brown plate from Punta de Agua (adapted from Wallace 2014:480), d) Vessel 575 Mimbres Pottery Images Digital Database (MimPiDD) from Cameron Creek (adapted from photographs in MimPiDD), and e) design from vessel 4009 unprovenanced, MimPiDD (adapted from photographs in MimPiDD). Illustrations by Shearon Vaughn.

Table 3. Artifacts Displaying a Bird-Snake Variation of Multiple Birds Biting Snake or One Bird Biting One Snake

Site Name	Artifact Type	Material	Temporal Association	Number of Artifacts	Reference
			Salt River		
Pueblo Grande	Red-on-buff sherds	Ceramic	Colonial Period	2	Bostwick and Downum 1994
La Villa	Red-on-buff Bowl	Ceramic	Late Gila Butte Phase	1	Wallace 2014
			Middle Gila River		
Snaketown	Red-on-buff sherds	Ceramic	Gila Butte Phase	5	Gladwin et al. 1975; Haury 1976
Snaketown	Red-on-buff sherds	Ceramic	Santa Cruz Phase	7	Gladwin et al. 1975; Haury 1976
Snaketown	Red-on-buff sherds	Ceramic	Sacaton Phase	4	Gladwin et al. 1975; Haury 1976
Snaketown	Red-on-buff Tripod Vessel	Ceramic	Middle Sacaton I	1	Wallace 2014
Near Casa Grande*	Red-on-buff sherds	Ceramic	Sacaton Phase	1	Jacobs 2010
Maricopa*	Red-on-buff sherds	Ceramic	Colonial-Sedentary Period	1	Jacobs 2010
			Gila Bend - Gila River		
Gila Bend*	Red-on-buff sherds	Ceramic	Colonial-Sedentary Period	1	Jacobs 2010
			Santa Cruz River - Tucson		
Punta De Agua	Red-on-brown plate	Ceramic	Rillito Phase	1	Greenleaf 1975
			Mimbres Valley		
Cameron Creek	Black-on-white bowl	Ceramic	Late Style II-Style III	1	Vessel 575, MimPiDD
Mimbres*	Black-on-white bowl	Ceramic	Late Style II	1	Vessel 6351, MimPiDD
Mimbres*	Black-on-white bowl	Ceramic	Middle Style III	1	Vessel 10343, MimPiDD
Mimbres*	Black-on-white bowl	Ceramic	Middle Style III	1	Vessel 4009, MimPiDD
Mimbres*	Black-on-white bowl	Ceramic	Middle Style III	1	Vessel 8179, MimPiDD

*Location and not a specific site name; [1]Mimbres Pottery Images Digital Database (MimPiDD)

and Johnson 1965). A variation on multiple birds with one snake was found on one vessel – small versions of this design were scattered across the vessel (Wallace 2014:480).

The Mimbres vessels include one bird with one snake and range in date from Late Style II to Middle Style III (see Figures 3d-e). On many of the pottery designs, the bird is holding the snake by its neck, although one design shows the bird holding the snake in the middle (see Figure 3d). Another design shows a mythological scene with a bird man holding a snake man by the neck and tail. There is variation in the depiction of the birds. A few of them are plump birds with long legs; although there is also a stylized pendant bird holding a coiled snake. For the most part, the snakes are depicted as relatively straight. The design on the snakes also vary slightly, being mostly solid, but occasionally with hatching or symbols. Hour-glass symbols occur on the body of the Mimbres snake (see Figure 3e).

An examination of the Mimbres Pottery Images Digital Database (MimPiDD) identified a total of 33 vessels that contained painted representations of snakes (including zoomorphic figures with snakes like traits). A total of seven of these "snakes" are interacting with birds. From the seven vessels with the bird and snake combination, five of the snakes are decorated with the hourglass motif (71%). In contrast, only four of the 26 snakes not accompanied by birds include the hourglass motif (15%), suggesting a probable association between the hourglass motif and the interaction of the type of snakes depicted with the birds. There is a low probability that this relationship occurred by chance (Fisher's Exact, two tailed, p=0.009).

Chronological Association of the Bird-Snake Motif

Chronological assignment of the motif includes both broadly measured time frames (e.g. Colonial period) and narrowly defined time frames such as Wallace's (2001, 2004) refined Hohokam chronology (e.g., Late Gila Butte). In general, the motif appears to date to the Hohokam Preclassic period, although there are two artifacts that have been identified in Classic period contexts (see Tables 1–3). The earliest chronological association for artifacts (n=8) with the bird-snake motif is the Gila Butte phase (Gladwin et al. 1975; Greenleaf 1975; Wallace 2014). The Santa Cruz phase artifacts (n=44) are skewed by the relatively large number of palettes that were assigned to the Santa Cruz phase (White 2004). The Sacaton phase artifacts contained the largest sample (n=53), including the examples from the Mimbres area. As previously mentioned, two examples were recovered from Classic period contexts, but it may be that these were heirloom items. The remaining artifacts were grouped into Colonial period (n=5), Colonial-Sedentary period (n=3), with a few from unknown temporal contexts (n=22).

As noted above, there are two stylized versions of the motif, one with an "m" as the bird and the other as a stylized feather. In his discussion on Hohokam design, Wallace (2001) notes that there is a trend for the simplification of motifs through time, which could contribute to a stylistic replacement of one version of the motif with another. Although there are both stylized and naturalistic versions of the motif, they are both coterminous, indicating that they are not the result of simplification of the motif through time.

Archaeological Distribution of the Bird-Snake Motif

This section describes the archaeological distribution of the bird-snake motif (Figure 4). The bird-snake motif extends across the southern Southwest and is roughly coincident with the distribution of the ballcourts in the Southwest (Figure 5; Wallace 2014:Figure 11.7; Wilcox and Sternberg 1983). The incorporation of the motif across cultural boundary groups (e.g., Mimbres) mirrors the pattern seen in other ideologies such as the Southwestern Regional Cult (Crown 1994).

Artifacts with the bird-snake motif have been observed at both villages that were dependent on irrigation technology and in areas without canals. Although there appears to be an association between villages with irrigation technology (or floodwater farming) and those villages that contained the variation of the motif with the bird holding the neck of the snake (see Tables 1–3).

Although most sites have only one type of artifact with the bird-snake motif, there were a few villages that

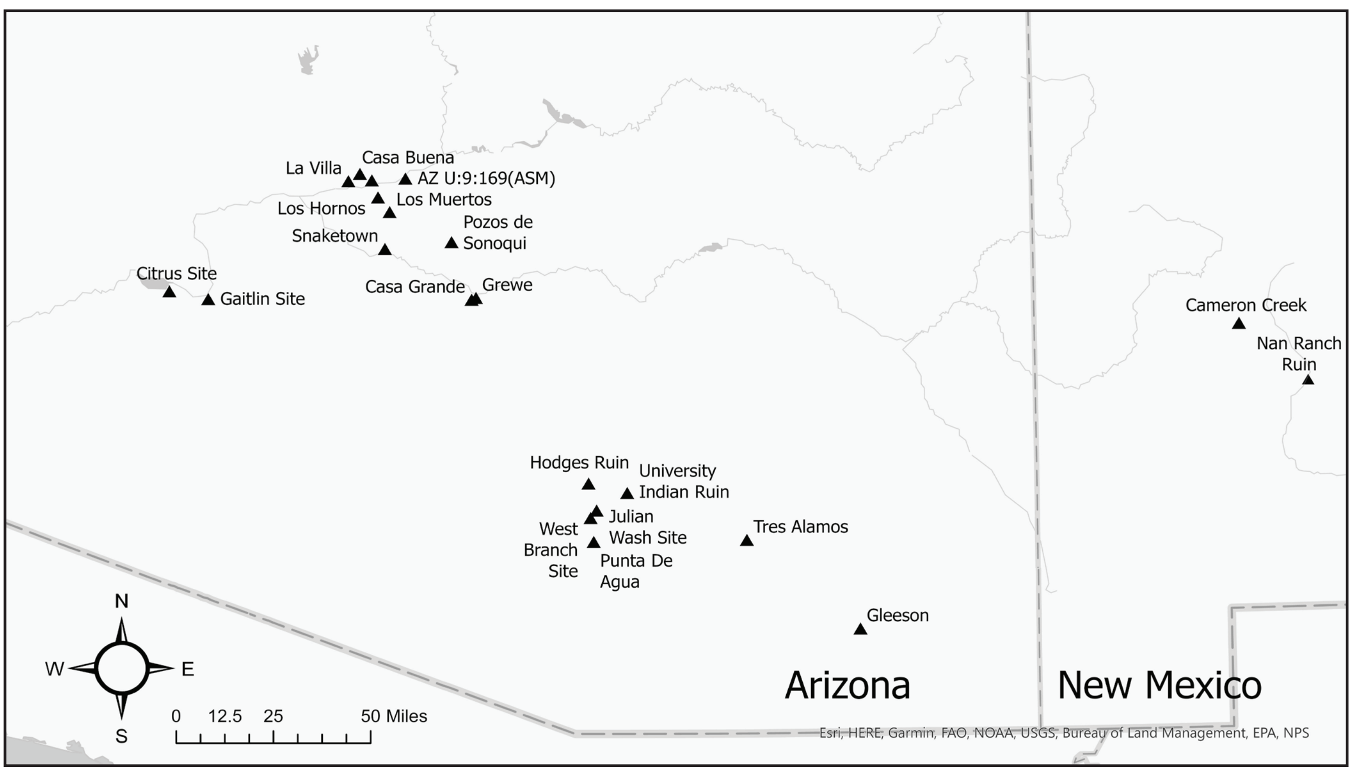

FIGURE 4. Archaeological distribution of the bird-snake motif across the southern Southwest.

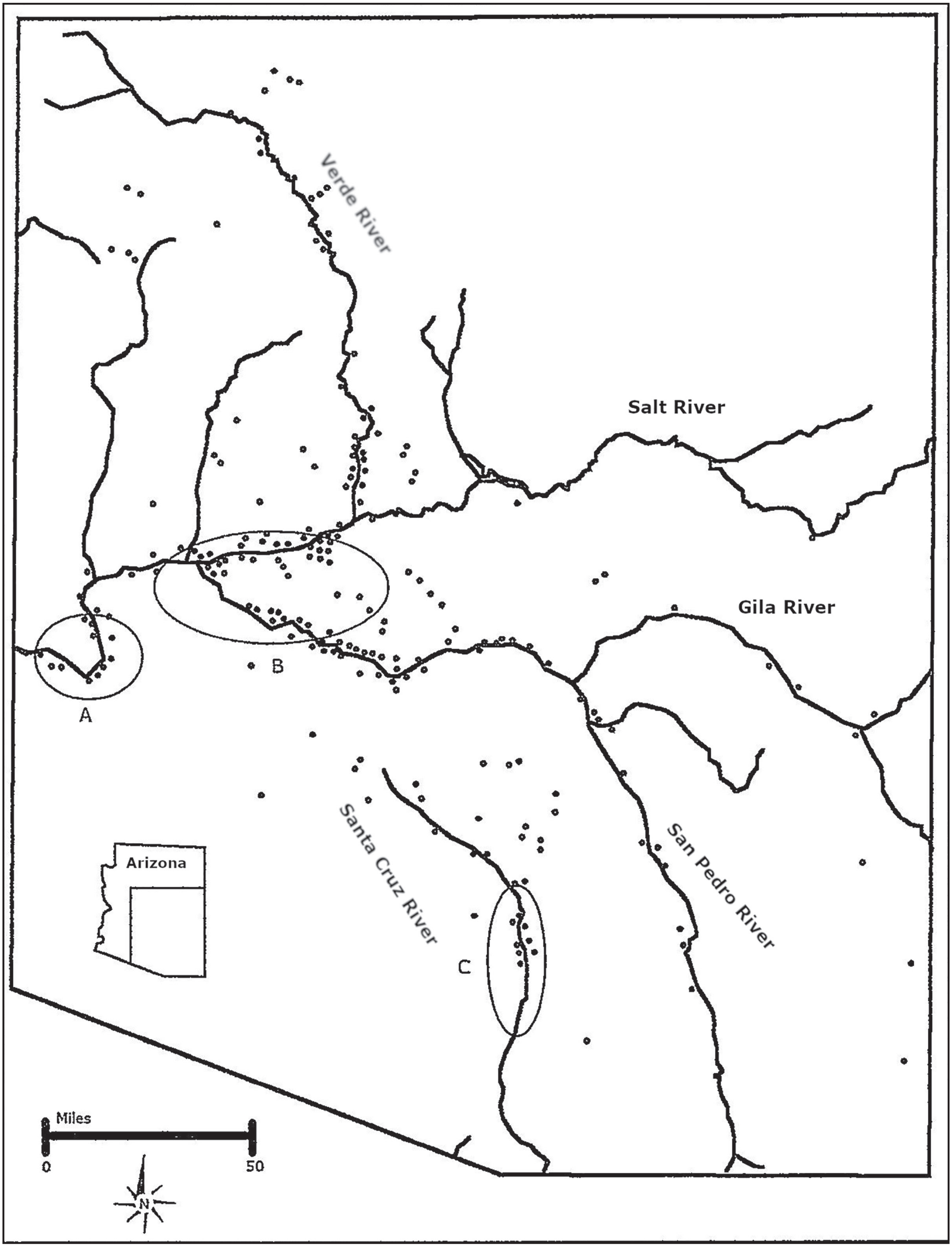

FIGURE 5. Distribution of Hohokam ballcourts with concentration areas of the bird-snake motif (adapted from Wallace 2014:457; a) Gila Bend of the Gila River, b) middle Gila River c) middle Santa Cruz River.

contained multiple artifact types with the bird-snake motif. These large villages can be described as regional centers that contain multiple ballcourts, ceremonial architecture, numerous residential areas, and are generally located along major river corridors (Wilcox 1991). These sites also contain other exotic materials from what is now Mexico, which further denotes their political influence in a regional setting (Bayman 2002). Multiple artifacts with the bird-snake motif were identified in four regional centers; the Citrus Site in the Gila Bend area, Snaketown and Grewe along the Middle Gila River, and NAN Ranch Ruin along the Mimbres River.

Although this review is not exhaustive, it is surprising that the bird-snake motif was not present in the large collection of shell artifacts and debris from the Hind Site or Shelltown, even though these villages were production locations for shell bracelets (Howard 1983). These sites did include frog and bighorn sheep motifs, albeit in very small quantities. This may suggest specialized production of the bird-snake motif shell artifacts and more restricted distribution.

ETHNOGRAPHIC REVIEW OF RAIN

The ethnographic review for this paper is focused on the accounts of the Akimel and Tohono O'Odham, as these Tribes are likely the descendants of the Hohokam (Loendorf and Lewis 2017). Although these Tribes shared many commonalities, they differ significantly in their subsistence practices. The Akimel O'Odham are river people who maintain irrigated agricultural fields along the Gila River; while the Tohono O'Odham subsist on wild resources and ak-chin agricultural fields in the desert away from major the rivers (Fontana 1983). Both groups, however, are heavily dependent on the rain.

Rain imagery and conceptual relationships with birds and snakes are explored in songs, stories, and rituals. The ethnographic literature provides the data to construct the argument that the bird-snake motif is a metaphor for rain. This section discusses the O'Odham model of rain.

The Southwest has two periods of rainfall each year. During the months of December and January, there is a light, gentle rainfall. In the summer months, from July to September, the rain is a heavy and torrential downpour. This cycle, with its associated imagery and duality, are interwoven into many O'odham stories, songs, and ceremonies. In the O'Odham worldview these two periods of rain have fundamental characteristics and symbology. The winter rain comes from the salt water ocean, being brought by ocean winds, and the ocean is considered a permanent body of water (Underhill 1976:111). Winter rains are associated with the west, and bring rain for the wild plants of the desert (Underhill et al. 1979:67). In contrast, the summer rains originate in the east and are associated with agricultural production for the Tohono O'Odham (Underhill et al. 1979:67). The clouds and the rain guardians reside in "rain houses" which are located in all four direction and resemble the council house of a village leader (Underhill 1969:22-23). Akimel O'Odham rain houses reside along the path of the sun and are divided into aspects associated with rain – such as lightning, thunder, wind, and foam upon the river (Russell 2017 [1908]:251). Rain is acquired when the owners of the rain houses are persuaded through petition and tobacco smoke to release the rains (Underhill et al. 1979:53). Earth Doctor is said to have control over the winds and rain (Russell 2017 [1908]:251).

Rain Symbols

The concept of rain in the O'Odham worldview is multifaceted. Birds, animals, reptiles, and objects may be connected, in whole or in part, with a particular aspect of the rain concept. As the main purpose is the connection of the bird-snake motif with the rain concept, this discussion is limited to water birds and rattlesnakes.

Water Birds

The bird representation on the bird-snake motif is most closely associated with water birds. For this study, water birds include cranes, herons, egrets, and ibises all of which are found in the southern Southwest, for at least part of the year. In Underhill's (1969, 1976; Underhill et al. 1979) descriptions of the O'Odham stories and songs, she often references "cranes." Rea (2007:110) argues that the correct avian association is the egret or heron.

O'odham stories involving water birds demonstrate their transportation ability as seen in the following three stories. One story involves Coyote causing a flood and then being saved by a heron. Instead of demonstrating gratitude to the heron, he derisively comments on the bird's long legs. The heron dumps Coyote into the river and he drowns (Rea 2007:109). Another story with Coyote and a flock of herons involves Coyote stranded on debris floating in the river. He sees a flock of herons. He calls out to them and asks if they will rescue him by putting their beaks on their neighbor's tail and making a bridge. They comply and make a bridge across to the other side of the river. Coyote begins walking on the heron bridge, and about midway through, insults the birds by stating that they "stink" at which point the birds fly off, leaving Coyote to drown in the river (Rea 2007:106). The final story also involves the transportation powers of the water birds, but across not just water, but into the realm of the dead. The younger brother (Nasia's Twins) journeys to the west (the land of the dead) in search of his paternal grandmother who has died. Reaching the shore of the ocean, he is unable to cross. He asks the heron to help him. The heron at the water's edge becomes large, spreads its wings and lets the boy walk across to the other side (Bahr 2001:120).

The stories above demonstrate that water birds are associated with the ocean and that they have inherent ability to transfer both themselves and others across different spaces. This transfer ability is seen between land and water, sky and ground, and between the land of the living and the realm of the dead.

According to Underhill (1976:107), the Tohono O'Odham view bird feathers as akin to clouds. Eagle feathers are especially associated with rain and often play an important role in ceremonies associated with rain. Specifically, it is the downy feathers from the eagle that are representative of clouds. This is memorialized in a portion of the creation story where Elder Brother kills Eagle Man and throws his downy feathers in all cardinal direction, creating clouds (Rea 2007:127). Birds are also associated with the above with their ability to fly across the sky.

Snakes, especially Rattlesnakes

In many instances, the snake representation on the bird-snake motif is unambiguously that of a rattlesnake because rattles are shown on the tail. For the O'odham, snakes are considered to be associated with summer rain (Rea 2007:61). As shown in the two versions of the story, rattlesnake is associated with death, cremation, and rebirth.

In one version of the story (Rea 1998:134-135; Russell 2017 [1908]:215-216), Rattlesnake "soft child" has rattles [but no fangs or venom] and is mistreated by those that gather at night in the communal house. I'itoi (Elder Brother) gives Rattlesnake some protection from those who are mistreating him by providing fangs and directions to bite anyone who bothers him. Cottontail (Rabbit) plays with Rattlesnake, is bitten by Rattlesnake, develops a sickness, and dies. This is the first death. No one knows how to bury Cottontail (Rabbit). Cremation is suggested and Coyote is sent to the Sun to get fire. Coyote returns with the fire and wants to see his brother Cottontail (Rabbit), but is prevented because they are preparing to burn the body. After searching the crowd, Coyote jumps over the heads of the people onto the pyre and steals Cottontail's (Rabbit's) heart, and begins to run around various parts of Arizona depositing ash and grease.

In another version of the story (Bahr 2001:22-23), Earth Doctor provides fangs and venom for relief of Rattlesnake's mistreatment by the people. Rabbit is the first death and the people were upset. Yellow Buzzard works with Green Frog to get revenge on Earth Doctor by sucking out his heart. This becomes the first sickness. Eventually Earth Doctor dies, they put him on a pyre and cremate him. Coyote steals the heart and runs, scattering ashes and spreading sickness as he travels. The stories diverge in that Earth Doctor's instructions to Rattlesnake also include the following statement: "If you kill him [by biting anyone who troubles you], you will also be the one to help him back to life again." (Bahr 2001:23). This version of the story was conveyed by William Blackwater.

This story conveys that rattlesnakes should be respected, and that Rattlesnake has both the power of death and rebirth. Although it is not specifically stated, it may be that the association with rebirth is related to the snake's ability to shed its skin and begin anew. Rattlesnakes are also associated with the underground or the below, which is part of the relationship with death and cremation.

Ceremonies Connected with Rain

Many of the O'Odham ceremonies are associated with causing rain to fall. Some ceremonies are primarily intended solely for this task while others are coupled with related rites. The following ceremonies are described briefly below with an emphasis on the rain symbolism and ritual.

Saguaro Wine Festival

The Saguaro Wine Festival is the first ceremony in the O'Odham year and its primary function is to celebrate the summer rains (Underhill et el. 1979). Around July, O'Odham families journey to their cactus camps to harvest the fruit and return to the village to brew the saguaro syrup into wine (Russell 2017 [1908]:170). It is a communal effort, and each family donates some of their syrup to the wine making festivities. Other villages were invited to the ceremony. Eagle feathers and tobacco were present in the "rain house" (e.g., village council house) where the beverage was brewed (Underhill 1976:24). The saguaro wine produces diarrhea and vomiting, which causes the drinker to expunge the contents from their body (Underhill et al. 1979:78). This act of saturating the body with wine until it is expelled is a metaphor for the saturation of the earth with rain (Underhill 1969:41). Furthermore, the act of vomiting is known as "throwing up the clouds" (Underhill 1969:67).

Salt Pilgrimages

Salt pilgrimages are a journey to the ocean to collect salt and power. Summer is the preferred time for salt pilgrimages as the high tides of spring leave large deposits of salt on the beaches (Underhill et al. 1979:37). Although the primary purpose is to obtain salt and power through dreaming, the secondary purpose is bringing rain from the ocean. It is believed that offerings must be made to the ocean, lest the winds will not blow and bring rains (Underhill 1976:111). Indeed, some of the speeches associated with the journey to the ocean refer to visiting with the guardians of the rain house to ask for rain (Underhill et al. 1979:55-57). Once the group arrived at the destination, the young men waded into the water, and deposited their offerings into the ocean (Underhill et al. 1979:60). The young men must endure an intensive purification process upon returning to the village (Underhill 1969:242). The Tohono O'odham would provide salt to the Akimel O'Odham when they came to exchange goods at harvest time (Russell 2017 [1908]:93-94).

Intervillage Games and the Skipping Dance

The games are an opportunity for exercise, gambling, and visiting with family. One of the inter-village competitions is known as the Skipping Dance; which was intended to bring rain to the host village (Rea 2007:107). In addition to practicing their running skills, the village prepares a musical performance and provides food for the guests (Underhill 1969:117). Songs were sung invoking rain imagery such as wind, clouds, or white cranes or gulls that fly from the ocean (Underhill 1976:152; Rea 2007:119). The dancing is performed by a row of boys and a row of girls, dancing and skipping (Underhill 1969:121). The performers carried effigies of birds [cranes], rainbows, and clouds (Underhill 1976:153). Rea (2007:107) indicated that although the birds were noted as coastal birds, the description best fits egrets.

Wi'igita/Harvest Festival/Prayer Stick Festival

Every fourth winter this ceremony is performed for the purpose of renewal and rebirth through keeping the world in order and preventing flooding (Underhill 1969:135). The ritual involved multiple villages, each of whom brought songs and village-specific aspects to the ceremony (Jones 1971:9). The observance also included a representation of the children (two boys and two girls) who sacrificed their lives to stop a great flood (Underhill 1969:146). The flood event is said to have occurred in prehistoric times, as water arising from a hole in the earth, and smelling of ocean air (Underhill et al. 1979:141-144). Village children are selected to dance in honor of the shrine of the Flood Children and are a focal point for all the processions (Underhill 1969:146). Symbols from the ceremony include prayer sticks placed within "fields" representing different villages (Underhill 1969:147) The songs for the ritual evoke numerous rain images, such as clouds, cranes, and crops (Underhill 1969:149-152).

The underlying theme among these various ceremonies is the necessity for rain in the desert and the resulting fertility associated with rain. At least a portion of each of the songs for the rituals above depict vivid imagery concerning clouds, thunder, and rain. The O'Odham ceremonies can be divided into two main parts as it relates to the concept of rain; bringing needed rain to the villages and controlling the rain so it does not result in devastating floods that cause damage. It is argued below that these two aspects of the rain may be associated with the subtle variations in the bird-snake motif.

DISCUSSION

The pervasiveness and longevity of the bird-snake motif across the southern Southwest is an indication that the motif represented a fundamental belief that was shared in an environment in which resource and water scarcity was a principal concern. This section brings together the evidence used to support the bird-snake motif as a metaphor for rain, discusses the significance of the subtle variations of the motif, and outlines future directions for further study.

Constructing the Bird-Snake Motif as a Metaphor for Rain

There are several lines of reasoning that are woven together to support the argument that the bird-snake motif is a metaphor for rain. These include the materials from which the artifacts are crafted; an association with water in the places where the motifs are observed; the linkages of water birds and snakes with ethnographic attributes associated with rain; rain ceremonies that incorporate these images; and the two components of the motif (the bird and the snake) representing the rain cycle.

Artifact Materials

Materials associated with the bird-snake motif includes shell, turquoise, schist, phyllite, ceramic, and bone. The bird-snake motif is commonly depicted on marine shell, which is naturally associated with water and the ocean. A few of the shell pendants from Citrus Site and NAN Ranch Ruin also had a turquoise inlay (Cosgrove and Cosgrove 1932; Wasley and Johnson 1965). As has been previously mentioned, turquoise has been associated with water and agricultural fertility (Russell et al. 2018). Stone palettes made of phyllite and micaceous schist tempered Hohokam buffware have a shiny quality that may be associated with water (Wallace 2014:478).

Association of Motif with Villages with Water

Many of the villages observed with the motif are either part of an irrigation system or in close proximity to a river. Tables 1-3 list the specific artifacts with the bird-snake motif and are organized by area through their association with a river system. As has been noted earlier, the ballcourt system in the Hohokam Preclassic period is very linear, mostly following river valleys (Gregory 1991).

Ethnographic Associations of Water Birds and Snakes with Rain

In general, water birds are both land and water dwellers, allowing them to transition across spaces. The water birds are also significant because of their connection with the sky and the above, where the rain clouds reside. As noted previously, the Tohono O'Odham associate feathers with clouds (Underhill 1976:107). Snakes are considered a summer rain animal (Rea 2007:61). The snake on the bird-snake motif is most likely a rattlesnake given the rattles on many of the motifs. Rattlesnakes have both the power of death and rebirth and have been associated with cremation. As creatures of the underground and the below, rattlesnakes are a very common motif on palettes.

Rain Ceremonies

The O'Odham ceremonies – Inter-village Games, Saguaro Wine Festivals, Salt Pilgrimages, and the Prayer Stick Festivals – are all associated with some aspect of rain. A major element of the ceremonies is control of water – starting the rain, continuing the rain, and preventing a flood. Images within the ceremonies include clouds, rain, shells, and birds. The Inter-village Games are for bringing rain to villages for crop growth (Underhill 1969:116); while the Saguaro Wine Festival is to keep it raining. Similarly, the Salt Pilgrimages help ensure future winter rains (Underhill 1976:111), while the Prayer Stick Festival is designed to prevent a flood (Teague 1993). Interestingly, no direct reference to snakes could be found in these ceremonies, even though the Prayer Stick Festival is known as a rebirth and renewal ceremony. In comparing the Hopi Wuwtsim ceremony with the Wi'igita ceremony, Teague (1993:448) speculated that the children were those sacrificed to the water serpent to stop the flood. No mention was made of a snake in the ethnographic descriptions of the Wi'igita ceremony and the Flood Children (Jones 1971; Mason 1921; and Underhill 1969).

Another aspect of the rain ceremonies is the amount of cooperation and collaboration needed to successfully carry out these events. Each of the ceremonies requires a ceremonial leader to guide the festivities, singers who are familiar with the songs, dancers, ritual specialists to perform specific tasks, and people to contribute food and drink to the performers and guests (Jones 1971). With the exception of the salt pilgrimages, the rest of the ceremonies involve other nearby villages. Indeed, Russell (2017 [1908]:352) indicated that "People must unite in desiring rain."

The Rain Cycle

The bird-snake motif may also be a representation of the rain cycle. As noted previously, there are two kinds of rain within the Southwest, winter rains and summer rains. The incorporation of white-water birds in the symbolism of the ceremonies also reiterate the association between clouds and water birds. Additionally, the transportation ability of the birds is symbolic of carrying the rain that falls from the clouds.

There is more dualism associated with the motif – the bird embodies the above or sky and the rattlesnake embodies the below and earth. This is further exemplified with the bird representing the ocean portion of winter rain cycle and the snake representing the summer rain season. In addition to the winter/summer portion of the rain cycle, the motif appears to demonstrate the rain process with the water evaporating (snake) into the sky and forming clouds (bird) and the clouds (birds) releasing the rain (snake).

Cultural Significance of the Variation in the Bird-Snake Motif

Stylistic variations in artifacts communicate information that is culturally meaningful and purposefully constructed (David et al. 1988; Wobst 1977). Although there may be many possible reasons for the variations depicted in the motif, the focus is on the variations that are cultural significant and contribute to the understanding of motif as a metaphor for rain. Specifically, the variations that modify the way the bird interacts with the snake may have been relevant to how the metaphor was interpreted. The possible cultural significance of these variations is discussed below.

Bird Holding the Head of the Snake in its Beak – Bring Forth Rain

The main variation of the motif includes the bird holding the head of the snake in its beak (see Figure 1a-c). This variation is depicted across all artifact types. From a naturalistic perspective, the bird could either be seen as eating the snake or regurgitating the snake. As rain is often seen pouring forth from clouds, it is a natural association. In some instances of this variation of bird-snake motif, there are two birds back to back, one bird holds the head of the snake, the other holds the tail of the snake, which may symbolize the complete rain cycle (see Figure 1b).

This particular variation of the motif corresponds most directly with a ritual associated with the Saguaro Wine Festival. During the Saguaro Wine Festival, community members drink the wine until they are saturated and vomit up the wine they have consumed. This practice is the physical embodiment of the rain process in which the clouds soak up the rain to saturation and pour forth the water onto the land. The "bird holding the head of a snake in its beak" variation of the bird-snake motif is a metaphor for summer rain.

Bird Holding the Neck of the Snake – Control of Moisture

One of the variations includes the bird holding the neck of the snake (see Figure 2). This variation is depicted on shell artifacts. As the snake is representative of rain, the depiction of this bird holding onto the neck of the snake could be interpreted as control of the snake, and hence control of the water. Archaeologically, there is one bracelet fragment with the bird holding the neck of the snake that was identified in a prehistoric canal at site AZ U:9:149(ASM), providing some support for this interpretation (Powell and Boston 2004).

A ritual aspect of the Prayer Stick Festival, the Flood Children, corresponds most directly with the bird holding the neck of the snake in its beak variation of the bird-snake motif. Children dancers, who are the personifications of the Flood Children, perform at the festival. The Flood Children, through sacrificing their lives, controlled the ocean water that threatened to flood the village. The bird holding the neck of the snake in its beak variation of the bird-snake motif is a metaphor for controlling the water to prevent flooding; whereas the bird characterizing the ocean holds the neck of the snake which represents the underground water, thereby controlling the flood.

The specific villages that observed the variation of the bird holding the neck of the snake were noted to be those villages associated with irrigation technology. The Hohokam irrigation systems were very dependent on the consistency of waterflow within the river where too much or too little water could be devastating for the agricultural fields (Waters and Ravesloot 2001). Therefore, the control over water would have been very meaningful for those villages that were reliant either on irrigation or ak-chin farming.

Multiple Birds Biting One Snake or One Bird Biting One Snake – Collaboration

Another variation of the bird-snake motif depicts multiple birds attacking one snake. This variation is depicted on ceramic vessels. Undoubtedly, this variation has the most diversity in design alternatives and likely has multiple associations.

One possible association for this variation can be seen in nature. There is a behavioral response called mobbing, where individuals of a prey species, such as black headed gulls, attack a predator, most often to protect their young (Kruuk 1964). Gathering together to work toward a shared goal is an adaptive strategy that humans have employed in the past. It is reasonable to assume that this variation may represent collaboration with other villages.

Many of the larger archaeological villages have demonstrated evidence of social interaction with other villages (Greenleaf 1975; Haury 1976; Lindeman 2015). Additionally, while there are known ballcourts at many of the villages associated with the bird-snake motif, the other areas were in close proximity to ballcourts as well (Wallace 2014:Appendix D). Abbott et al. (2007) demonstrated that ballcourts drew crowds of people from multiple villages, providing a venue and opportunity for collaboration.

Based on the ethnographical literature, the rain theme is woven throughout many different ceremonies, and many ceremonies involve multiple villages. It may be possible that the multiple birds are representative of several villages joining together to perform the rituals necessary for the rain to flow. The implementation of rain ceremonies requires the collaboration of ritual specialists of the village to prepare the necessary components for the ceremony.

For both villages that are along irrigation canals and those that are practicing ak-chin farming, there are ways to minimize risks associated with the unpredictability of rainfall. Sharing of resources through alliances and movement to nearby areas are possible risk strategies for surviving localized situations where lack of water or overabundance of water has created a loss of agricultural resources (Rautman 1983; Strawhacker et al. 2020). Ethnographically, this practice was observed by Russell (2017 [1908]:171) with the "Name Song" that was used as a social device to organize distribution of foods to those groups suffering from food shortages. Essentially, the female visitors learn the names of the prosperous female villagers and put their names to song; then the female visitor attempts to capture the female villager and ransom the female villager for the value of her husband's name in foodstuffs. In this way, the groups that suffered from food shortage could be helped by their neighbors, with the understanding that the visit be returned (Russell 2017 [1908]:171).

Further Directions for Future Study

The slight variations in the motif designs between Hohokam and Mimbres ceramics are worth further investigation. Both groups included the hourglass symbol within the pottery design, but the association of the hourglass with each component of the motif is different. The Mimbres hourglass was on the body of the snake, whereas in the Hohokam, it forms the body of some of the birds. Is it interesting to note that the hourglass symbol is not included in lists of small elements commonly found in Hohokam ceramic design, suggesting that its purpose was different than just a design element

(Haury 1976; Wallace 2001, 2004). The hourglass has been noted in rock art to be associated with warfare (Schaafsma 2000). Warriors were associated with the acquisition of rain based on the belief that the enemy's power could be captured and channeled into bringing rain (Underhill 1969:165-166). Further investigations could elaborate on the association of the bird-snake motif with warfare.

Additionally, the majority of the artifacts associated with the bird-snake motif were crafted as an item of personal adornment. These types of artifacts were often associated with the identity of the wearer (Bayman 2002). Furthermore, images like the bird-snake motif may convey a socio-political role of the individual using the artifact (Robb 1998). For instance, the carved shell bracelets with the bird holding the neck of the snake could have provided a visual display of the authority of the individual in maintaining the canal system for the village. The potential for the bird-snake motif to serve as visual representations of low to mid-levels of leadership in the villages is worth further investigation.

CONCLUSION

This paper proposed that the bird-snake motif is a metaphor for rain. In addition to imagery on ceramics, raw materials that have symbolic association with water, such as shell and turquoise, were used to craft artifacts with the bird-snake motif. These artifacts have been identified at many sites across the southern Southwest but were primarily concentrated in regional centers with irrigation technology. Ethnographic literature regarding the Akimel and Tohono O'Odham shows that water birds and snakes are associated with rain. Subtle variations of the motif may be culturally relevant and relate to acquiring and controlling rain. The bird-snake motif may also be a visual representation of the rain cycle as demonstrated by the carved shell bracelets that contain back-to-back birds with one holding the head of the snake and the other holding the tail.

The examination of the metaphorical aspects of the O'Odham concepts and imagery expressed in the ethnographic literature was useful for interpreting the role of the bird-snake motif in the Hohokam Ballcourt Society. This highlights the importance of the undervalued cultural continuities of the Hohokam and O'Odham culture history. O'Odham stories, songs and ceremonies also provide a reminder of the complexities and image laden symbolism associated with ceremonies. Archaeologists tend to discuss prehistoric rituals in more simplicity than may be warranted; although these intangibles are not easily examined in the archaeological record.

Although much remains to be learned with regard to the bird-snake motif, this study presented possible meaning for the bird-snake motif that can be further elaborated with more data. In future archaeological investigations, consideration of potential symbolic associations should be noted.

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REFERENCES CITED

Abbott, David R., Alexa M. Smith, and Emiliano Gallaga
2007 Ballcourts and Ceramics: The Case for the Hohokam Marketplaces in the Arizona Desert. *American Antiquity* 72(3):461–484.

Adams, E. Charles
1991 *The Origin and Development of the Pueblo Katsina Cult.* University of Arizona Press, Tucson.

Bahr, Donald (editor)
2001 *O'Odham Creation & Related Events As told to Ruth Benedict in 1927 in Prose, Oratory and Song by the Pimas – William Blackwater, Thomas Vanyiko, Clara Ahiel, William Stevens, Oliver Wellington, & Kisto*. University of Arizona Press, Tucson.

Bayman, James M.
2002 Hohokam Craft Economies and Materialization of Power. *Journal of Archaeological Method and Theory 9(1):69–95.*

Bohrer, Vorsila L.
1991 Recently Recognized Cultivated and Encouraged Plants Among the Hohokam. *Kiva* 56:227–235.

Bostwick, Todd W.
2002 *Landscape of the Spirits: Hohokam Rock Art at South Mountain Park*. University of Arizona Press, Tucson.

Bostwick, Todd W., and Christian E. Downum
1994 Site Structure and Ceremony at Pueblo Grande. In *Archaeology of the Pueblo Grande Platform Mound and Surrounding Features: Volume 2, Features in the Central Precinct of*

the Pueblo Grande Community, edited by Todd W. Bostwick and Christian E. Downum, pp. 297–386. Pueblo Grande Museum Anthropological Papers No. 1, Phoenix, Arizona.

Bostwick, Todd W., Stephanie M. Whittlesey, and Douglas R. Mitchell
2010 Reconstructing the Sacred in Hohokam Archaeology: Cosmology, Mythology, and Ritual. *Journal of Arizona Archaeology* 1(1):89–101.

Bradfield, Wesley
1931 *Cameron Creek Village: A Site in the Mimbres Area in Grant County, New Mexico*. Monographs of the School of American Research No. 1, School of American Research, Santa Fe, New Mexico.

Ciolek-Torrello, Richard
1997 Prehistoric Settlement and Demography in the Lower Verde Region. In *Vanishing River: Landscapes and Lives of the Lower Verde Valley,* edited by Stephanie M. Whittlesey, RRichard Ciolek-Torrello and Jeffrey H. Altschul, pp. 531–596. SRI Press, Tucson, Arizona.

Cosgrove, Harriet S., and C. Burton Cosgrove
1932 *The Swarts Ruin: A Typical Mimbres Site in Southwestern New Mexico. Report of the Mimbres Valley Expedition, Seasons of 1924–1927*. Peabody Museum of American Archaeology and Ethnology Papers No. 15 (1). Cambridge, Massachusetts.

Crown, Patricia
1991 The Hohokam: Current Views of Prehistory and the Regional System. In *Chaco & Hohokam: Prehistoric Regional Systems in the American Southwest,* edited by Patricia L. Crown and W. James Judge, pp. 135–157. School of American Research Press, Santa Fe, New Mexico.

1994 *Ceramics and Ideology: Salado Polychrome Pottery*. University of New Mexico Press, Albuquerque.

David, Nicolas, Judy Sterner, and Kodzo Gavua
1988 Why Are Pots Decorated? *Current Anthropology* 29(3):365–389.

Doelle, William H., and Henry D. Wallace
1991 The Changing Role of the Tucson Basin in the Hohokam Regional System. In *Exploring the Hohokam: Prehistoric Desert Peoples of the American Southwest,* edited by George J. Gumerman, pp. 279–346. Amerind Foundation Publication, University of New Mexico Press, Albuquerque.

Doyel, David E.
1980 Hohokam Social Organization and the Sedentary to Classic Transition. In *Current Issues of Hohokam Prehistory,* edited by David E.Doyel and Fred Plog, pp. 22–40. Anthropological Papers 23. Arizona State University, Tempe.

Ezell, Paul H.
1963 Is There a Hohokam-Pima Culture Continuum? *American Antiquity* 29:61–66.

Fish, Paul R.
1989 1,000 Years of Prehistory in the Sonoran Desert. In *Dynamics of Southwest Prehistory,* edited by Linda S. Cordell and George J. Gumerman, pp. 19–64, School of American Research Advanced Seminar Book, Smithsonian Institution Press, Washington D.C.

Fontana, Bernard L.
1983 Pima and Papago: An Introduction. In *Handbook of North American Indians*. Volume 10: Southwest, edited by Alfonso Ortiz and William C. Sturtevant, pp. 125–136. Smithsonian Institution, Washington, DC.

Fulton, William S., and Carr Tuthill
2012 *An Archaeological Site Near Gleeson, Arizona*. Originally published 1940. Amerind Foundation, Dragoon, Arizona. Reprinted version.

Gasser, Robert E., and Scott J. Kwiatkowski
1991 Regional Signatures of Hohokam Plant Use. *Kiva* 56 (3):207–226.

Gilman, Patricia A., Marc Thompson, and Kristina C. Wyckoff
2014 Ritual Change and the Distant: Mesoamerican Iconography, Scarlet Macaws, and Great Kivas into the Mimbres Region of Southwestern New Mexico. *American Antiquity* 79(1):90–107.

Gladwin, Harold S., Emil W. Haury, E. B. Sayles, and Nora Gladwin
1975 *Excavations at Snaketown: Material Culture*. Originally published 1938. University of Arizona Press, Tucson. Reprinted version.

Graybill, Donald A.
1989 The Reconstruction of Prehistoric Salt River Streamflow. In *The 1982–1984 Excavations at Las Colinas: Environment and Subsistence,* by Donald A. Graybill, David A. Gregory, Fred L. Nials, Suzanne K. Fish, Robert E. Gasser, Charles

H. Miksicek, and Christine R. Szuter, pp. 25–38. Archaeological Series No. 162, vol. 5. Cultural Resource Management Division, Arizona State Museum, University of Arizona, Tucson.

Greenleaf, J. Cameron
1975 *Excavations at Punta De Agua in the Santa Cruz River Basin, Southeastern Arizona*. Anthropological Paper of the University of Arizona No. 26. University of Arizona Press, Tucson.

Gregory, David A.
1991 Hohokam Settlement Patterns. In *Chaco & Hohokam: Prehistoric Regional Systems in the American Southwest*, edited by P. Crown and J. Judge, pp. 159–194, School of American Research Advanced Seminar Series, Santa Fe, New Mexico.

Haury Emil W.
1945 *The Excavations of Lose Muertos and Neighboring Ruins in the Salt River Valley, Southern Arizona*. Peabody Museum of American Archaeology and Ethnology Papers No. 24 (1). Peabody Museum, Cambridge, Massachusetts.

1976 The Hohokam: Desert Farmers & Craftsmen (Snaketown 1964–1965). University of Arizona Press, Tucson.

Hays-Gilpin, Kelley, and Jane H. Hill
1999 The Flower World in Material Culture: An Iconographic Complex in the Southwest and Mesoamerica. In *Journal of Anthropological Research*. 55(1)1–37.

Howard, Ann V.
1983 Marine Shell Artifacts and Production Processes at Shelltown and the Hind Site. In *Shelltown and the Hind Site: A Study of Two Hohokam Craftsman Communities in Southwestern Arizona.* Volume 1, edited by William S. Marmaduke and Richard J. Martynec, pp. 321–423. Northland Research, Flagstaff, Arizona.

Howard, Jerry B., and Gary Huckleberry
1991 *The Operation and Evolution of an Irrigation System: The East Papago Hohokam Canal Study*. Publications in Archaeology, No. 18. Soil Systems, Phoenix, Arizona.

Huckleberry, Gary
2008 Santa Cruz River Alluvial Stratigraphy, Drexel to Irvington Reach, Tucson, Arizona. In *The Parque de Santa Cruz Project: Life on the Northern Margin of the Valencia Community,* edited by Michael W. Lindeman and Helga Worcherl, pp. 58–108. Desert Archaeology, Tucson, Arizona.

Ingram, Scott E.
2008 Streamflow and Population Change in the Lower Salt River Valley of Central Arizona, ca. 775-1450. *American Antiquity* 73:136–165.

Jacobs, Mike
2010 A Portfolio of Hohokam Life Forms in the Norton Allen Collection. *Journal of the Southwest* 52(2–3):255–276.

Jernigan, E.Wesley
1978 *Jewelry of the Prehistoric Southwest*. School of American Research – Southwest Indian Arts Series. Santa Fe, New Mexico.

Jones, Richard D.
1971 The Wi'igita of Achi and Quitobac. *The Kiva* 36(4):1–32.

Kelly, Isabel T.
1978 *The Hodges Ruin: A Hohokam Community in the Tucson Basin*, with the collaboration of James E. Officer and Email W. Haury, edited by Gayle Harrison Hartmann. Anthropological Paper No. 30, University of Arizona Press, Tucson.

Kruuk, Hans
1964 *Predator and Anti-Predator Behavior of the Black Headed Gull*. E. J. Brill Leiden, Netherlands.

Lakoff, George, and Mark Johnson
1980 *Metaphors We Live By*. University of Chicago Press, Chicago.

Lindeman, Michael W. (editor)
2015 *Excavations at La Villa: Continuity and Change at an Agricultural Village*. Technical Report No. 2012-008. Desert Archaeology, Tucson, Arizona.

Loendorf, Chris, and Barnaby V. Lewis
2017 Ancestral O'Odham: Akimel O'Odham Cultural Traditions and the Archaeological Record. *American Antiquity* 82(1): 123–139.

Mason, J. Alden
1921 The Papago Migration Legend. *Journal of American Folklore* 34(133): 254–268.

McClelland, John A.
2015 Revisiting Hohokam Paleodemography. *American Antiquity* 80:492–510.

Moulard, Barbara
1984 *Within the Underworld Sky: Mimbres Ceramic Art in Context*. Twelvetrees Press, Pasadena, California.

Nials, Fred L., and David A. Gregory
1989 Irrigation Systems in the Lower Salt River Valley. In *The 1982-1984 Excavations at Las Colinas: Environment and Subsistence,* by Donald A. Graybill, David A. Gregory, Fred L. Nials, Suzanne K. Fish, Robert E. Gasser, Charles H. Miksicek, and Christine R. Szuter pp. 39–58. Archaeological Series No. 162(5). Arizona State Museum, University of Arizona, Tucson.

Nials, Fred L., James Holmlund, and Susan Hall
2004 Prehistoric and Historic Canals. In *Ancient Farmers of the Safford Basin: Archaeology of the US 70 Safford to Thatcher Project*, edited by Jeffrey J. Clark, pp. 59–83. Anthropological Paper No. 39. Center for Desert Archaeology, Tucson, Arizona.

Nicholas, Linda, and Gary M. Feinman
1989 A Regional Perspective on Hohokam Irrigation in the Lower Salt River Valley, Arizona. In *The Sociopolitical Structure of Southwestern Societies,* edited by Steadman Upham, Kent G. Lightfoot, and Roberta A. Jewett, pp. 199–235. Westview Press, Boulder, Colorado.

Powell, Shirley, and Richard L. Boston (editors)
2004 *Life on the Lehi Terrace: The Archaeology of the Red Mountain Freeway Between State Route 87 and Gilbert Road*. Cultural Resources Report No. 135, Archaeological Consulting Services, Tempe, Arizona.

Rautman, Allison E.
1993 Resource Variability, Risk, and the Structure of Social Networks: An Example from the Prehistoric Southwest. *American Antiquity* 58:403–424.

Rea, Amado
1998 *Folk Mammalogy of the Northern Pimans.* University of Arizona Press, Tucson.

2007 *Wings in the Desert: A Folk Ornithology of the Northern Pimans*. University of Arizona Press, Tucson.

Rice, Glen E.
2001 Warfare and Massing in the Salt and Gila Basins of Central Arizona. In *Deadly Landscapes: Case Studies in Prehistoric Southwestern Warfare*, edited by G. Rice and S. LeBlanc, pp. 289–330, University of Utah Press, Salt Lake.

Robb, John
1998 The Archaeology of Symbols. *Annual Review of Anthropology* 27:329–346.

Russell, Frank
2017 *The Pima Indians.* Originally published in 1908. Twenty-Sixth Annual Report of the Bureau of American Ethnology, 1904–1905. Smithsonian Institution, Washington, D.C. Reprinted Version.

Russell, Will G., Sarah Klassen, and Katherine Salazar
2018 Lines of Communication: Mimbres Hatchure and Concepts of Color. *American Antiquity* 83(1): 109–127.

Schaafsma, Polly
1980 *Indian Rock Art of the Southwest.* University of New Mexico Press, Albuquerque.

2000 *Warrior, Shield, and Star: Imagery and Ideology in Pueblo Warfare*. Western Edge Press, Santa Fe, New Mexico.

Strawhacker, Collen, Grant Snitker, Matthew A. Peeples, Ann P. Kinzig, Keith W. Kintigh, Kyle Bocinsky, Brad Butterfield, Jacob Freeman, Sarah Oas, Margaret C. Nelson, Jonathan A. Sandor, and Katherine A. Spielman
2020 A Landscape Perspective on Climate-Drive Risks to Food Security: Exploring the Relationship between Climate and Social Transformation in the Prehispanic U.S. Southwest. *American Antiquity* 85(3):427–451.

Teague, Lynn S.
1993 Prehistory and the Traditions of the O'Odham and Hopi. *Kiva* 58(4): 435–454.

Thompson, Marc, Patricia Gilman, and Kristina Wyckoff
2014 The Hero Twins in the Mimbres Region: Representations of Mesoamerican Creation Saga Are Seen on Mimbres Pottery. *American Archaeology* 18(2):3–43.

Tilley, Christopher (series editor)
1999 *Metaphor and Material Culture*. Social Anthropology Series. Blackwell Publishers, Oxford, United Kingdom and Malden, Massachusetts.

Tuthill, Carr
1947 *The Tres Alamos Site on the San Pedro River Southeastern Arizona*. Amerind Foundation, Dragoon, Arizona.

Underhill, Ruth M.

1969 *Papago Indian Religion.* Columbia University Press, New York. Originally published in 1946. Reprinted Version. AMS Edition, New York.

1976 *Singing for Power: The Song Magic of the Papago Indians of Southern Arizona*. Originally published in 1938. University of California Press, Berkeley, Los Angeles, and London. California Library Reprint Version, Series Cloth Edition.

Underhill, Ruth M., Donald M. Bahr, Baptisto Lopez, Jose Pancho, and David Lopez

1979 *Rainhouse & Ocean: Speeches for the Papago Year*. University of Arizona Press, Tucson.

Wallace, Henry D.

2001 Time Seriation and Typological Refinement of the Middle Gila Buffware Sequence. In *The Grewe Archaeological Research Project,* Vol. 2: *Material Culture,* Part I: *Ceramic Studies*, edited by David R. Abbott, pp. 177–262. Anthropological Papers No. 99-1. Northland Research, Tempe, Arizona.

2004 Update to the Middle Gila Buff Ware Ceramic Sequence. In *Hohokam Farming on the Salt River Floodplain: Refining Models and Analytical Methods,* edited by T. Kathleen Henderson, pp. 59–141. Anthropological Papers No. 43. Center for Desert Archaeology, Tucson, Arizona.

2007 Birds and Serpents in Hohokam Art. *Archaeology Southwest* 21(1):8*.*

2014 Ritual Transformation and Cultural Revitalization: Explaining Hohokam in the Pre-AD 1000 Southeastern Arizona. In *Between Mimbres and Hohokam: Exploring the Archaeology and History of Southeastern Arizona and Southwestern New Mexico*, edited by Henry D. Wallace, pp. 433–500.Archaeology Southwest, Tucson, Arizona.

Wallace, Henry D., and William H. Doelle

2001 Classic Period Warfare in Southern Arizona. In *Deadly Landscapes: Case Studies in Prehistoric Southwestern Warfare,* edited by Glen E. Rice and Steven A. LeBlanc, pp. 239–288. University of Utah Press, Salt Lake.

Wasley, W. William, and Alfred E. Johnson

1965 *Salvage Archaeology in Painted Rocks Reservoir Western Arizona*. Anthropological Papers of the University of Arizona No. 9. University of Arizona Press, Tucson.

Waters, Michael R., and John C. Ravesloot

2001 Landscape Change and the Cultural Evolution of the Hohokam along the Middle Gila River and other River Valleys in South-Central Arizona. *American Antiquity*. 66 (2):285–300.

White, Devin Alan

2004 *Hohokam Palettes*. Arizona State Museum Archaeological Series No. 196. Arizona State Museum, University of Arizona, Tucson.

Wilcox, David R.

1991 Hohokam Social Complexity. In *Chaco and Hohokam: Prehistoric Regional Systems in the American Southwest*, edited by Patricia L. Crown and W. James Judge, pp. 252–276. School of American Research Press, Santa Fe, New Mexico.

Wilcox, David R., and Charles Sternberg

1983 *Hohokam Ballcourts and Their Interpretation*. Arizona State Museum Archaeological Series 160. University of Arizona, Tucson.

Wilcox, David R., Terry Samples, Donald Keller, and Maria Laughner

1996 The Wagner Ballcourt Community and Other Cohonina Sites. *Kiva* 61(4):433–456.

Wobst, H. Martin

1977 Stylistic Behavior and Information Exchange. In *For the Director: Research Essays in Honor of James B. Griffin,* edited by Charles E. Cleland, pp. 317–342. Anthropological Papers No. 61. Museum of Anthropology, University of Michigan, Ann Arbor.

Woodson, M. Kyle

2010 Re-Drawing the Map of Hohokam Canals in the Middle Gila River Valley. *Journal of Arizona Archaeology* 1(1):5–20.

Woodward, Arthur

1931 The Grewe Site – Gila Valley, Arizona. In *Los Angeles Museum of History Science and Art Occasional Paper No. 1*. Los Angeles Museum.

Wright, Aaron M., Pat H. Stein, Barnaby V. Lewis, and William Doelle

2015 *The Great Bend of the Gila: A Nationally Significant Cultural Landscape.* Archaeology Southwest, Tucson, Arizona.

LA PLAYA PURPLE-ON-BROWN: A NEW TRINCHERAS CERAMIC TYPE FROM LA PLAYA (SON F:10:03)

Hunter M. Claypatch

Despite nearly a century of archeological investigations in northern Sonora, little attempt has been made to seriate the region's prehistoric Trincheras ceramic tradition. In this paper, I provide a comparative analysis of decorated pottery from the site of La Playa (SON F:10:03) against sherds from three newly excavated sites along the Río Altar. Using this study, I argue for the implementation of a new ceramic type—La Playa Purple-on-brown. Chronometric dates suggest that La Playa Purple-on-brown was produced prior to the eighth century. The identification of a new ceramic type provides a significant advancement not only for the seriation of Trincheras decorated pottery, but for understanding larger themes in prehistoric ceramic production. Future research will clarify whether La Playa Purple-on-brown antecedes Trincheras Purple-on-brown/red and whether its production was spatially restricted to the Río Boquillas.

The Trincheras tradition emerged in northern Sonora, Mexico, around 200 AD and persisted for approximately 1,200 years. Despite the region's potential value for answering questions of cultural connectivity and early ceramic horizons, archaeologists have made little attempt to organize Trincheras pottery through space and time. This paper offers new insight into the region by analyzing ceramics from the site of La Playa (SON F:10:03) and from several sites in the Altar Valley. I begin with a cultural historical background of the Trincheras tradition that targets ongoing issues with chronology and ceramic seriation. A discussion of recent findings from the site of La Playa follows. Next, I provide a systematic comparison of La Playa pottery with several sites found along the Río Altar. I argue that several sherds from La Playa are representative of a newly identified ceramic type—La Playa Purple-on-brown. I conclude with an evaluation of this type's possible spatial and temporal sensitivity.

CULTURE HISTORY OF THE TRINCHERAS TRADITION

The Trincheras heartland was located between the Río Concepción and Río San Miguel of northern Sonora, Mexico. The first archaeological investigations in the region occurred during the late 1920s (Gladwin and Gladwin 1929). Since then, Trincheras material culture has been typified by specular, purple-painted pottery produced using crushed hematite (Ownby and Myrhman 2020; Sauer and Brand 1931). Periodic work in southern Arizona between the 1930s and 1970s established a so-called "Santa Cruz contact zone"—a cultural division between the Hohokam and Trincheras traditions that closely aligned to the modern international border (Reinhard and Shipman 1978:247). The arbitrary presence of an international border has ensured that significantly less academic and cultural resource management projects have been conducted in the Trincheras heartland than in southern Arizona (for notable exceptions see Bowen 1972; Hinton 1955; Johnson 1960).

The establishment of *Centro Regional del Noroeste* (later renamed Centro INAH Sonora) in 1973 advanced archaeology in northern Mexico.[1] Since then, Mexican archaeologists have conducted dozens of archaeological surveys and excavations that produced numerous *informes* (technical reports) on findings from throughout Sonora. Many notable projects have also been conducted with the binational collaboration of US and Mexican archaeologists (including: Carpenter et al. 2015; Douglas and Quijada 2004; McGuire and Villalpando 1993; 2011).

Thomas Bowen (1972) initially proposed a tentative chronology for the Trincheras tradition; however, McGuire and Villalpando (1993) made revisions following their survey of the Altar Valley. McGuire and Villalpando's chronology arranged the Altar Valley into three primary phases: Atil Phase (~200–800 AD), Altar Phase (800–1300 AD), and El Realito phase (1300–1450

1 INAH, or *Instituto Nacional de Antropología e Historia*, is a centralized government institution that is responsible for the excavation, preservation, and interpretation of all archaeological sites within Mexico.

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Table 1. Dated Features from La Playa (SON F:10:03) Containing Trincheras Decorated Sherds

Feature	Feature Type	Area	Decorated Sherds (n)	Calibrated Date (1σ) / 68.2%	Calibrated Date (2σ) / 95.4%	Reference
146	Horno	Los Entierros	1	1410–1110 BC	1550–900 BC	Villalpando and Carpenter (2005)
213	Horno	El Canal	4	600–660 AD	540–680 AD	Villalpando and Carpenter (2005)
313	Cremation	El Canal	1	10–80 AD	40 BC–120 AD	Villalpando and Carpenter (2005)
317	Burial	Hornos Alineados	1	420–550 AD	390–610 AD	Villalpando and Carpenter (2005)
381	Horno	Los Montículos	2	330/340–440 AD	320–540 AD	Villalpando and Carpenter (2005)
600	Structure	Viejo Campamento	14	434–565 AD	427–585 AD	Villalpando et al. (2018)

AD). Material culture associated with the El Realito Phase resembles Papaguerían Hohokam assemblages from southern Arizona. These similarities have led archaeologists to believe that Papaguerían populations migrated to the Altar and Magdalena Valleys around 1300 AD (Chiykowski 2016; McGuire and Villalpando 2015). Later excavations at the site of Cerro de Trincheras (SON F:10:02) identified a distinct phase, El Cerro (1300–1450 AD), along the Río Magdalena. This phase is contemporaneous to El Realito, but defined by a later Trincheras occupation on terraced volcanic hills (McGuire and Villalpando 2011).

RECENT EXCAVATIONS AT LA PLAYA

Sauer and Brand (1931) first described La Playa (SON F:10:03) nearly 90 years ago. The site covers approximately 10 km^2 along the Río Boquillas, near Trincheras, Sonora. It has received considerable notoriety for its unbroken archaeological sequence that spans the Paleoindian period to the present day (Carpenter et al. 2015). Despite its research appeal, archaeologists only periodically studied La Playa until the 1990s.[2] In 1996, the Centro INAH Sonora launched the *Proyecto La Playa* after concern that erosion would destroy precious archaeological evidence that remained at the site (Carpenter et al. 2009).

The majority of excavations conducted through *Proyecto La Playa* have targeted the site's Early Agricultural Period (EAP) occupations (1200 BC–0 AD). This research demonstrates that the site's material culture and bioarchaeology are nearly identical to contemporaneous occupations in Arizona's Tucson Basin (Claypatch 2018:13–15; Morales 2006:55–57; Watson 2011:3). Copious quantities of worked marine shell from La Playa further suggest that the site figured prominently in large-scale trade prior to the first centuries of the common era (Pastrana and Villalpando 2002).

Despite focus on EAP occupations, La Playa has yielded thousands of artifacts associated with the Trincheras tradition—including over 5,000 decorated sherds and six radiocarbon dated features containing purple-on-brown pottery (Abrego 2014; Bernal 2005; Gómez et al. 2016; Rincón 2010; Santoyo 2011; Villalpando and Carpenter 2005; Villalpando et al. 2018) (Table 1). Two features (146 and 313) yielded radiocarbon dates that precede the Trincheras tradition but contained only one Trincheras decorated sherd. The presence of Trincheras pottery in these two features was almost certainly the result of postdepositional contamination. Furthermore, it is unlikely that the single decorated sherd from Feature 313 was from the same depositional activity as its cremation. The remaining three features (213, 381, and 600) are represented by two *hornos* and a habitation structure. These features yielded radiocarbon dates ranging from the fourth to the seventh century AD.

Feature 600 provides the best context for dating Trincheras pottery from the site. The feature is located within a portion of the site known as *Viejo Campamento* and was excavated by archaeologists in 2016. It is a burnt jacal structure that contained three post holes and a small storage cist (Feature 601) (Abrego et al. 2016:48). Fourteen of the 19 sherds were decorated Trincheras sherds, with the remaining five identified as plain ware (Gómez et al. 2016). Sherds were concentrated on the lowest levels of the structure (levels 3 and 4) and a carbonized reed fragment yielded a date range of 1523 to 1365 cal BP (427–585 AD) (Elisa Villalpando, personal communication 2020; Villalpando et al. 2018:37). One thousand sixty-three sherds surrounding Feature 600 were also recovered during the excavation. These sherds included an extremely high percentage (87.1%) of Trincheras decorated pottery. Two Sweetwater Red-on-gray (~675–700 AD)[3] sherds were also collected (Gómez et al. 2016:124). These sherds are some of the

2 Alfred Johnson's (1960) master's thesis on La Playa is a notable exception.

3 I use dates provided by Wallace (2004) for all Hohokam ceramic types and Periods found within this article.

only examples of Preclassic Hohokam pottery found within the Trincheras heartland (Claypatch 2018:34).

HISTORY OF TRINCHERAS CERAMIC STUDIES

Ezell (1954:16) broadly classified all Trincheras and Papaguerían Hohokam pottery as "Sonora Brown Ware." I question the validity of this ware because Trincheras and Hohokam potters implemented different secondary forming techniques. Trincheras vessels were constructed using coil-and-scrape. This technique is frequently accompanied by prominent scrape marks on vessel interiors. By contrast, Hohokam vessels were constructed using paddle-and-anvil methods (McGuire and Villalpando 1993:29–32).

Gladwin and Gladwin (1929) and Sauer and Brand (1931) provided the initial typologies for Trincheras decorated ceramics; however, McGuire and Villalpando's (1993) Altar Valley survey established revisions that are still used by archaeologists in the region. This typology includes several plain types, Trincheras Purple-on-red, Trincheras Purple-on-brown, and two polychrome types—Altar Polychrome and Nogales Polychrome.[4] All decorated pottery is broadly unified by the application of purple paint (sometimes specular) on surfaces that may be slipped or polished.

McGuire and Villalpando (1993:71–72) lacked chronometric dates, but tentatively proposed that production of Trincheras Purple-on-brown/red began prior to 700 AD. Later chronometric dates from Cerro de Trincheras demonstrated that this type persisted until 1400–1450 AD (McGuire and Villalpando 2011). Despite proposed production over nearly a millennium, virtually no attempt has been made to seriate Trincheras decorated pottery. Thomas Bowen argued that Trincheras Purple-on-brown/red were "equivalent to hypothetical types consisting of all Anasazi black-on-white pottery or all Hohokam red-on-buff" (Bowen 1972:81). His statement remains poignant when considering that nearly fifty years have passed with little advancement in its seriation.

Three issues have historically stifled the study of Trincheras ceramics. First, early Anglo interpretations positioned the region as culturally "retarded" when compared to Hohokam material culture (Gladwin and Gladwin 1929:129). This perception bias resulted in several decades of academic disinterest. Furthermore, despite extensive work in recent decades by Mexican archaeologists, the majority of archaeological data is only available in *informes*. Most US archaeologists are either unaware of these *informes* or are unwilling or unable to read reports written in Spanish (McBrinn and Webster 2008). Finally, collections of Trincheras sherds reside within museum collections from across the United States and Mexico. A detailed study requires international travel and binational collaboration between museums and institutions.

RESEARCH DESIGN

Since 2017, I have undertaken an intensive study of Trincheras pottery that aims to revise existing typologies into spatially and/or temporally restricted categorical units. It is my belief that a rigorous study of Trincheras ceramics across space and time will provide critical insights into larger trends of ceramic production across the borderlands. Historically, the Altar and Magdalena Valleys have been the source of most intensive research; however, Trincheras sherds have been documented at nearly 350 sites that extend from the Sea of Cortez to the Sierra Madre Occidental and as far north as the Phoenix Basin (Bowen 1976:65; Haury 1937:214; Gallaga 1997:105–106). These findings have also been coupled with a growing number of chronometric dates that range from the fourth to the fourteenth centuries (McGuire and Villalpando 2011:841; Villalpando et al. 2018:37).

Proyecto Tradición Trincheras was initiated in 2017 and aims to resolve fundamental questions of how the Trincheras tradition changed through time. During two field seasons, the archaeologists excavated at three sites in Sonora's Altar Valley: *La Potranca* (SON F:02:04), *El Póporo* (SON F:02:61), and San Martin (SON F:02:82). These sites were initially believed to represent three distinct phases; however, both *La Potranca* and *El Póporo* contain evidence of multiple occupations. Excavations yielded nearly 200,000 sherds and approximately 10,000 examples of Trincheras decorated pottery—the highest quantity ever recovered from excavated contexts.

During *Proyecto Tradición Trincheras*, it became apparent that existing typologies could not account for the tremendous morphological variability within Trincheras Purple-on-brown/red sherds. I examined sherds from Centro INAH Sonora's study collection, published photographs, and recently excavated materials to construct a graphical guide for Trincheras design motifs and morphological attributes. This guide, inspired by the work of Abbott et al. (2012) in the Phoenix Basin, has resulted in the identification of over 30 design motifs which are frequently replicated on Trincheras sherds across Sonora and Arizona (Figure 1).

4 Trincheras Purple-on-brown and Trincheras Purple-on-red are two types; however, there is disagreement in how these names are applied. This paper frequently uses "Trincheras Purple-on-brown/red" to refer to both possible types.

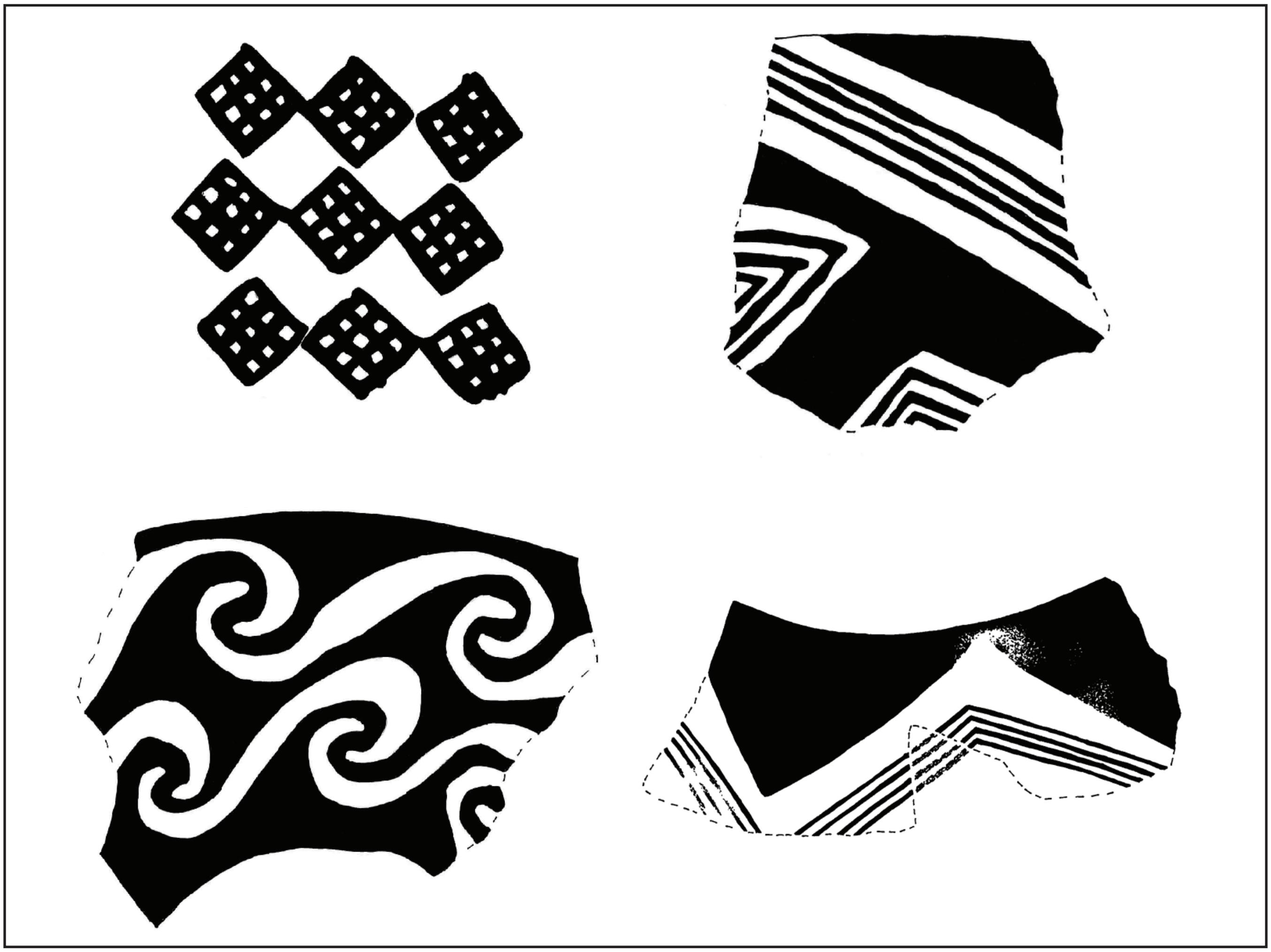

FIGURE 1. Trincheras motifs frequently found in the Altar Valley and extreme southern Arizona. (Top Row): "Gridded Square" and "Solid/Banded Opposition." (Bottom Row): "Long Scroll" and "Solid/Banded Opposition" (extending directly from "Sawtooth Rim" pattern). Sherds drawn by author and used with permission from Centro INAH Sonora.

I selected pottery from La Playa (SON F:10:03), along the Río Boquillas, to test the value of my graphical guide and to determine if they could be rendered typologically distinct from sherds recently excavated in the Altar Valley. Identifying typological differences between pottery from La Playa and sherds from the Altar Valley required two steps: 1) a comparison of design motifs to demonstrate if any were unique to La Playa and 2) a comparison of four vessel attributes to determine if ceramics with distinct design motifs possessed any additional diagnostic attributes.

I documented four vessel attributes during my comparative study: thickness, interior scraping, presence of polish, and use of specular or nonspecular hematite pigment. Archaeologists have long interpreted the presence of a specular hematite paint and interior vessel scraping as hallmarks of Trincheras pottery (Bowen 1972:79; Braniff 1992:577; Claypatch 2018:27–28; Johnson 1960:63; Villalpando 2007:254). Documentation of paint specularity, interior scraping, and polish were consistently monitored through use of representative control sherds. These control sherds were selected prior to commencing the investigation. I arranged thickness into four size classes: <4 mm, 4–4.99 mm, 5–5.99 mm, and >5.99 mm. Thickness was only measured on body portions of a sherd. Furthermore, only sherds with a visible red slip were recorded as "purple-on-red." This designation was made because previous archaeologists inconsistently used the term "purple-on-red" to describe either sherds with an added red slip or those with an unslipped red surface (Bowen 1972:73–77; Heckman 2001:77–81).

Centro INAH Sonora's ceramic study collection contains approximately 200 decorated Trincheras sherds that were recovered from La Playa. Many of these sherds were extremely fragmentary; however, 76 examples possessed a significant portion of their original design motifs. This sample originated from multiple areas within the site, including Los Montículos, Dos Pisos, and La Concheria 1.

I then selected a group of 988 sherds from the Altar Valley for comparison. Each selected sherd weighed a minimum of 12 grams. The vast majority of sherds originated from the three sites recently excavated by *Proyecto Tradición Trincheras*: SON F:02:04 (n=351), SON F:02:61 (n=399), and SON F:02:82 (n=204). To ensure variability within decorated pottery from the Altar Valley, I also selected 34 sherds from 16 additional sites that McGuire and Villalpando surface collected in 1988 (Table 2).

Not all sherds possessed sufficient data for the attributes I was analyzing. I only recorded interior scraping if the sherd was an olla or seed jar body fragment.[5] Other sherds were too eroded to adequately record thickness, specularity, or polish. Furthermore, several sherds refit with one another. Refitting pieces were only counted as a single sherd during the analysis. This criterion ensured that data was not improperly skewed by several sherds from the same vessel.

Table 2. Sites Used for Ceramic Analysis

Site Number	Site Name	Sherd Count	Collection Method
SON F:02:04	La Potranca	351	Excavation
SON F:02:13	–	2	Survey
SON F:02:17	Sitio Pobre	1	Survey
SON F:02:24	–	1	Survey
SON F:02:25	El Águila Quemada	1	Survey
SON F:02:33	Sitio Presa	1	Survey
SON F:02:36	–	1	Survey
SON F:02:38	Jefad	3	Survey
SON F:02:39	La Parabolica	5	Survey
SON F:02:48	Sitio Dia Bisiesto	3	Survey
SON F:02:52	–	1	Survey
SON F:02:53	Búho	2	Survey
SON F:02:56	Carmen	4	Survey
SON F:02:59	Zorro Muerto	3	Survey
SON F:02:60	Caballo	1	Survey
SON F:02:61	El Póporo	399	Excavation
SON F:02:82	San Martin	204	Excavation
SON F:06:17	–	1	Survey
SON F:06:18	–	4	Survey
SON F:10:03	La Playa	76	Excavation/ Survey

RESULTS

My comparative analysis of 76 sherds from La Playa against 988 sherds from the Altar Valley resulted in the identification of 30 La Playa sherds that exhibited design motifs either unknown, or extremely uncommon, in sherds from other sites. I subsequently refer to these sherds as "*LP Group A*" to distinguish them from the remaining 46 sherds examined from La Playa ("*LP Group B*"). Ceramics from *LP Group B* possessed design motifs which were frequently also seen on ceramics from the Altar Valley. Twenty *LP Group A* sherds were classified as either ollas or seed jars. Four of the sherds were portions of olla rims and three were seed jar rim fragments. Only one bowl rim sherd was observed; however, two unusual vessel handles were also identified. All but one sherd lacked an added red slip to the vessel surface. Forty-six percent of these sherds (n=14) were recovered from Los Montículos and 23% (n=7) were from La Concheria 1. The remaining nine sherds originated from Dos Pisos, Los Entierros, Obsidiana, and Pozo 1.

The two motifs most frequently observed in *LP Group A* were a "checkerboard" and "rake pattern" motif. The "checkerboard" motif (n=11) resembles a modern gaming board and appeared in several varieties, including a "solid checkerboard," a "parallel band checkerboard," and a "diamond checkerboard" (Figure 2: C-F). The "rake pattern" (n=10) consists of groups of thin parallel lines on the vessel (Figure 2: A and B). In many respects, this pattern mimics the interior scraping found on Trincheras vessel interiors. Design motifs assigned to the remaining nine sherds were unique and were entirely unknown on sherds from the Altar Valley. These motifs included a "solid dot" and "thin chevron" motif. Two of these unique examples came from vessel handles.

Two unique rim motifs (Figure 2: G and H) were also observed in *LP Group A*—one consisting of short tick marks that ran parallel to the rim and another with long, thin, linear bands extending perpendicular to the rim. Although the sample size was small, there appeared to be no clear correlation between rim motif style and

5 During the analysis, jars were distinguished between fragments with necks (ollas) and those without (seed jars). It was not possible to form this distinction on sherds that lacked rims. These body sherds were classified as "Olla or seed jar."

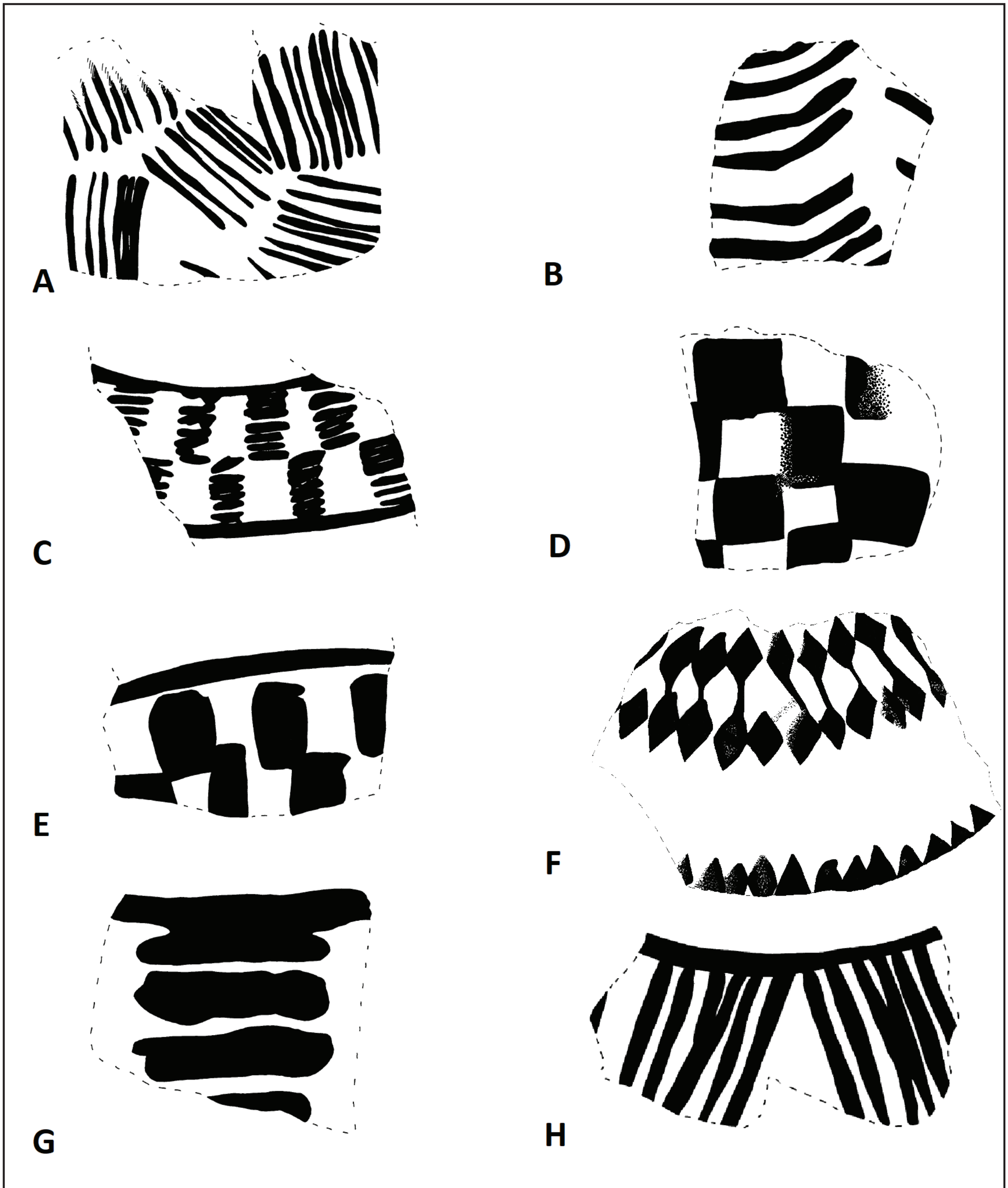

FIGURE 2. Motifs that characterize "LP Group A." (A and B) "Rake pattern" motif, (C) "Parallel Band Checkerboard," (D and E) "Solid Checkerboard," (F) "Diamond Checkerboard," (G) horizontal rim patterning (on bowl) and (H) vertical rim patterning (on seed jar). All drawings by author and used with permission from Centro INAH Sonora.

vessel form. In no case was the "sawtooth" rim design, previously described by Johnson (1960:62) found on *LP Group A* sherds. It was, however, observed on three olla rim sherds from *LP Group B*.

Ninety-two percent of *LP Group A* sherds possessed evidence of polishing (Table 3). Although this percentage is very high, it is not significantly greater than polishing on *LP Group B* sherds (83.3%). Trincheras Purple-on-brown/red sherds from the Altar Valley were less polished than both groups from La Playa. Only 27.5% of *LP Group A* sherds had evidence of specular paint. When present, paint was only lightly specular and differed from numerous highly specular examples from the Altar Valley. This percentage is also less than *LP Group B* sherds (52.1%) or from all other sites in the Altar Valley. San Martin (SON F:02:82) possessed the highest percentage of specular paint (79.3%).

One hundred percent of *LP Group A* olla or seed jar body sherds possessed interior scraping. By contrast, interior scraping occurred on only 82.1% of *LP Group B* sherds. Sherds from the Altar Valley were similar to *LP Group B*: 68.2% (SON F:02:04), 82.3 percent (SON F:02:61), and 86.2 percent (SON F:02:82). Finally, *LP Group A* sherds were thinner, on average, than those documented in *LP Group B* and at sites within the Altar Valley (Figure 3). Thirty nine percent of *LP Group A* sherds were thinner than 4 mm and 71.3% were less than 5 mm thick. *LP Group B* sherds and all sites within the Altar Valley were generally much thicker—with >5.99 mm as the most frequent size class.

La Playa Purple-on-brown

Trincheras Purple-on-brown and Trincheras Purple-on-red have been used in archaeological literature for nearly a century. Despite ongoing use, these types obfuscate extensive morphological variability and are spatially and temporally ambiguous. Furthermore, there is no clear consensus among archaeologists regarding these two ceramic types—particularly whether or not Trincheras Purple-on-red exclusively refers to red-slipped pottery or any decorated sherd with a natural red-fired surface (Bowen 1972:73–77; Heckman 2001:77–81). I advise that Trincheras Purple-on-brown and Trincheras Purple-on-red ultimately be replaced by typological categories that are morphologically, spatially, and temporally distinct.

The 30 analyzed sherds assigned to *LP Group A* differ from the other Trincheras Purple-on-brown/red sherds. Not only were the motifs found on *LP Group A* extremely distinct, they were thinner, more frequently possessed

Table 3. Results of Vessel Attribute Study

		Sites											
		La Playa				Altar Valley							
Sherd Attributes		LP Group A		LP Group B		SON F:02:04		SON F:02:61		SON F:02:82		16 Misc. Sites	
Total Analyzed Sherds		N=30		N=46		N=351		N=399		N=204		N=34	
		n	%	n	%	n	%	n	%	n	%	n	%
Thickness	Sherds Used for Study	28	93.3	46	100	348	99.0	372	93.2	202	99.0	34	100
	<4.00mm	11	39.2	5	10.8	7	02.0	24	06.4	9	04.4	1	02.9
	4.00–4.99mm	9	32.1	8	17.3	20	05.7	52	13.9	64	31.6	7	20.5
	5.00–5.99mm	6	21.4	16	34.7	63	18.1	94	25.2	56	27.7	6	47.0
	>5.99mm	2	07.1	17	36.9	258	74.1	202	54.3	73	36.1	10	29.4
Interior Scraping	Sherds Used for Study	20	66.7	28	60.9	164	46.7	147	36.8	58	28.4	10	29.4
	Present	20	100	23	82.1	112	68.2	121	82.3	50	86.2	9	90.0
	Absent	0	00.0	5	17.8	52	31.7	26	17.6	8	13.7	1	10.0
Specular Paint	Sherds Used for Study	29	96.7	46	100	333	94.9	357	89.4	199	97.5	33	97.1
	Present	8	27.5	24	52.1	132	39.6	177	49.5	158	79.3	9	57.5
	Absent	21	72.4	2	47.8	201	60.3	180	50.4	41	20.6	14	42.4
Polish	Sherds Used for Study	25	83.3	42	91.3	346	98.6	347	87.0	194	95.1	22	66.7
	Present	23	92.0	35	83.3	248	71.6	227	65.4	125	64.4	14	63.6
	Absent	2	08.0	7	16.6	98	28.3	120	34.5	69	35.5	8	36.3

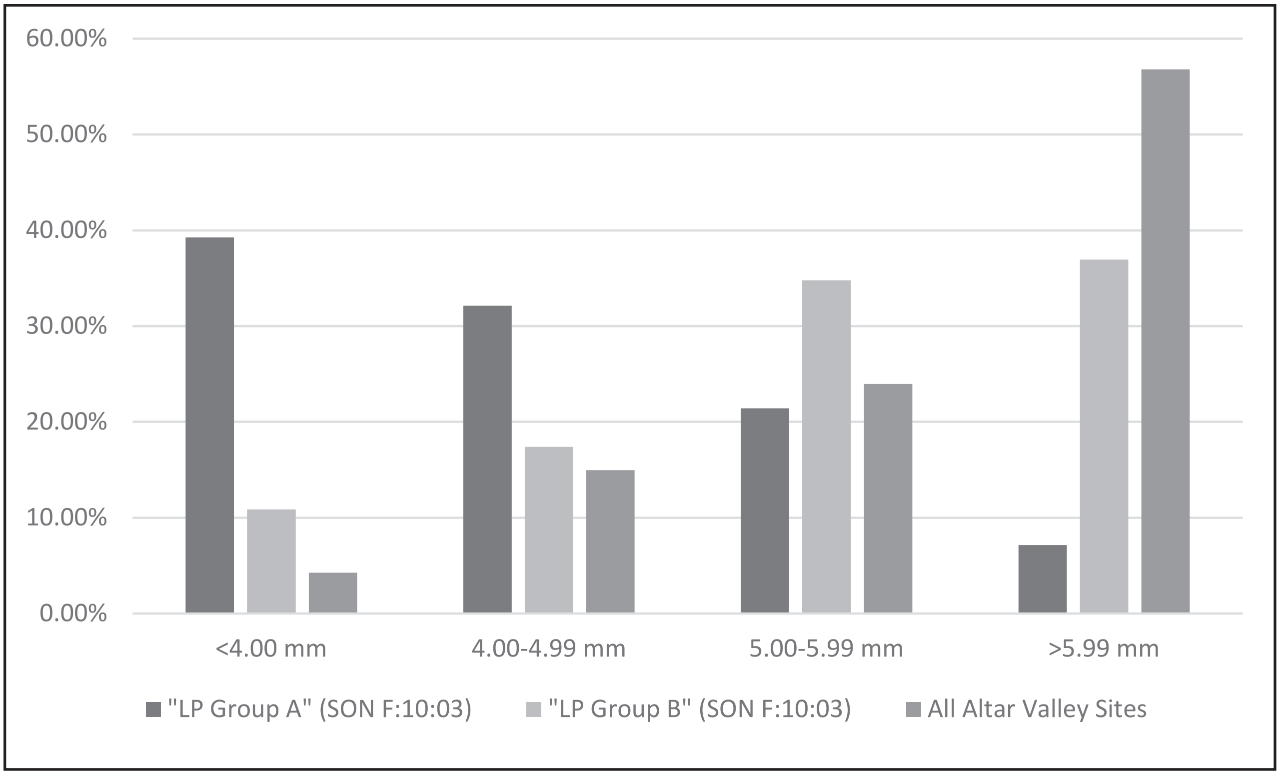

FIGURE 3. Thickness of Trincheras decorated sherds.

interior scraping, and contained less specularity in their pigments. I argue that *LP Group A* should be recognized as a new ceramic type: La Playa Purple-on-brown (Figure 4).[6] Only one sherd from *LP Group A* contained evidence of a red slip. It is possible that future research may recognize "La Playa Purple-on-red" as a distinct type; however, current analysis more aptly suggests that it is rare variety of La Playa Purple-on-brown.

Until replacement types for Trincheras Purple-on-brown/red are fully realized, Trincheras Purple-on-brown will still be used to satisfy all decorated pottery that cannot be definitively classified as La Playa Purple-on-brown. Sherds containing motifs seen in Figure 1, that possess high specularity, or that lack interior scraping on olla or seed jar bodies, should still be classified as Trincheras Purple-on-brown. Published sherds and partial vessels from Cemetery Ridge, El Macayo, and Aldea Inesperada in southern Arizona depict clear examples of Trincheras Purple-on-brown motifs (Doyel 1977; Heckman 2001; Montgomery and Deaver 2000). The typological descriptions for Trincheras Purple-on-red, Nogales Polychrome, and Altar Polychrome, remain unchanged, as these types incorporate an additional color (for paint and/or slip) that is not seen on La Playa Purple-on-brown.

6 See Supplemental Material provided after References Cited for a typological description.

A Spatially and/or Temporally Restricted Type?

Whether La Playa Purple-on-brown is spatially and/or temporally restricted is paramount to ongoing seriation of Trincheras pottery. Although morphological attributes clearly demonstrate that La Playa Purple-on-brown is typologically distinct from Trincheras Purple-on-brown, significant gaps still exist within our understanding of local ceramic production. In this section, I summarize available chronometric and distributional studies before concluding with my assertion that production of La Playa Purple-on-brown likely antecedes the eighth century.

Spatial Evidence

Currently, only three petrographic studies have been conducted within the Altar and Magdalena valleys. These studies overwhelmingly suggest that the entire life cycle of Trincheras vessels (manufacture, use, and deposition) were restricted to a single river valley (Chiykowski 2016:138; Gallaga 1997:117–118; Morales 2006:106). Juan Morales (2006:106) analyzed several Trincheras sherds from La Playa and demonstrated that nearly all examples originated from local clay sources within the Middle Magdalena Valley. Many of these sherds are now part of Centro INAH Sonora's study collection and were subsequently reidentified as

FIGURE 4. The type example for La Playa Purple-on-brown. Left: exterior, right: interior. These refitting sherds were excavated from area Los Montículos at La Playa (SON F:10:03). Photo taken by author and used with permission from Centro INAH Sonora.

La Playa Purple-on-brown during this study (Morales 2006:69–79).

Several sites in the Magdalena Valley are within 20 kilometers of La Playa—including: Cerro de Trincheras (SON F:10:02), Cerro La Nana (SON F:10:06), and Los Crematorios (SON F:10:151). Magdalena Valley ceramics have been less systematically studied than those in the Altar Valley; however, my analysis of a small study collection from Cerro de Trincheras, and of published photographs from Los Crematorios (Macías 2012), suggest that nearly all sherds were Trincheras Purple-on-brown/red. Unfortunately, these sites postdate Trincheras features from La Playa (Macías 2012:293; McGuire and Villalpando 2011:841; Villalpando 2012:2) and offer little to determine La Playa Purple-on-brown's spatial and temporal placement.

An extremely small quantity of La Playa Purple-on-brown sherds have been recorded within the Altar Valley. Of the 988 analyzed sherds from this valley, I assigned seventeen (1.7%) to this type. This included eleven sherds recently excavated by *Proyecto Tradición Trincheras* and six previously collected on survey. Nearly all of these sherds possessed a characteristic "parallel band checkerboard" motif, although a "diamond checkerboard" motif was also observed from SON F:02:36. A single sherd from San Martin (SON F:02:82) was classified as La Playa Purple-on-brown but possessed red slip. None of these sherds were found within dated features and temper studies cannot confirm if they were locally produced within the Altar Valley.

Temporal Evidence

La Playa Purple-on-brown's association with chronometric dates that precede the eighth century are intriguing; however, possible post-depositional processes, or "old wood" must also be considered (Schiffer 1986). The radiocarbon date for La Playa's Feature 600 was obtained from burnt reed used to construct the structure's jacal walls (Elisa Villalpando, personal communication 2020). Furthermore, the association between La Playa Purple-on-brown and the reed fragment is supported by the high frequency of sherds from the feature's lowest levels (Gómez et al. 2016:124). Sweetwater Red-on-gray sherds excavated from near Feature 600 are also consistent with occupation no later than 700 AD.

Published photographs from several La Playa *Informes* suggest that nearly 50% of decorated sherds contain motifs found on La Playa Purple-on-brown (see Abrego 2014; Bernal 2005; Gómez et al. 2016; Rincón 2010; Santoyo 2011). Gómez et al. (2016) provided images of several sherds from Feature 600 and the surrounding excavation area, and several more were taken by the author during a week-long geospatial survey of Viejo Campamento. Approximately two-thirds of photographed sherds contained motifs that are diagnostic for La Playa Purple-on-brown. The remaining sample was extremely fragmentary and typologically ambiguous. No motifs characteristic of Trincheras Purple-on-brown/red were identified from these images.

Snaketown (AZ U:13:01[ASM]) is possibly the only other site to yield Trincheras pottery in contexts prior to the eighth century. Haury (1937:214) recovered eleven Trincheras sherds (then known as "Sonora Red-on-brown") from the site. All contextually assignable sherds were placed within the Pioneer Period (475–750 AD). Subsequent re-excavation of Snaketown confirmed Trincheras sherds were found within Pioneer

Period (475–750 AD) and succeeding Colonial Period (750–950 AD) contexts. These findings represent the earliest non-local decorated pottery at the site (Haury 1976:328). Ownby and Myhrman's (2020:9–10) recent study of Trincheras sherds housed at the Huhugam Heritage Center demonstrates that only one sherd from Snaketown possessed specular paint. The single exception was a Nogales Polychrome sherd from Colonial Period (750–950 AD) contexts (Haury 1976:328). These sherds require reevaluation; however, such limited use of specular paint has only been observed on La Playa Purple-on-brown sherds from La Playa.

DISCUSSION

Several lines of evidence currently support the production of La Playa Purple-on-brown prior to 700 AD. First, La Playa's Feature 600 yielded numerous examples of La Playa Purple-on-brown and a radiocarbon date ranging from the mid fifth to late sixth century. This date range is corroborated by two additional excavated hornos. Second, La Playa has previously yielded dozens of radiocarbon dates from the EAP to the La Playa Phase (~0–350 AD) (Villalpando and Carpenter 2005). Such dates have been widely accepted by archaeologists (see Cajigas 2019; Carpenter et al. 2018; Watson 2011) and demonstrate that La Playa was utilized for centuries prior to the earliest evidence for Trincheras decorated pottery. Carpenter et al. (2015:227) have previously argued that the Trincheras tradition emerged in-situ from the preceding EAP and La Playa Phase occupations. Current chronometric dates associated with La Playa Purple-on-brown support that La Playa was a birthplace for nascent Trincheras pottery production. Furthermore, Snaketown demonstrates that Trincheras sherds were the earliest non-local pottery to enter the site—occurring within contexts prior to 750 AD. The recovery of Sweetwater Red-on-gray sherds from the area surrounding Feature 600 also support this date and strongly suggest that the Phoenix Basin and Trincheras heartland were interconnected prior to 700 AD. Procurement of shell from the Sea of Cortez for jewelry manufacture is currently the most rational explanation for these associations (Pastrana and Villalpando 2002).

No other site in northern Sonora has yielded chronometric dates contemporaneous with those from La Playa. The absence of such sites should not be mistaken for a scarcity of contemporaneous occupations. Instead, this dearth stems from our current inability to properly differentiate Trincheras phases from surface assemblages (McGuire and Villalpando 1993:71–72). Until more sites are analyzed and properly dated, it is impossible to determine if La Playa Purple-on-brown was produced concurrently with Trincheras Purple-on-brown/red or for how long it was produced. Nor can it be determined if La Playa Purple-on-brown reflects a local ceramic type that was only rarely produced, or traded, outside of the Río Boquillas.

CONCLUSION

In this paper, I introduced a new ceramic type, La Playa Purple-on-brown, and suggested that it was produced prior to the eighth century. Introducing La Playa Purple-on-brown into archaeological literature facilitates many new research questions. These questions are currently spatial and temporal; however, future research should aim to bring Trincheras pottery into larger discussions of cultural connectivity and identity. La Playa Purple-on-brown also sets a precedence for systematically studying Trincheras pottery and provides researchers with means to compare assemblages in new ways. Current research cannot firmly establish whether this type antecedes Trincheras Purple-on-red/brown, the two were produced simultaneously, or if La Playa Purple-on-brown represents an extremely localized member of the Trincheras decorated series. I hope that this study prompts further interest and will lead to an eventual seriation of Trincheras pottery.

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DATA AVAILABILITY STATEMENT

All ceramics analyzed for this study are located in Sonora, Mexico. Ceramics from La Potranca (SON F:02:04), El Póporo (SON F:02:61), and San Martin (SON F:02:82) are located at the Zona Arqueológica, Cerro de Trincheras, Trincheras, Sonora. Ceramics from La Playa (SON F:10:03), and those previously surface collected in the Altar Valley, are housed at Centro INAH Sonora, Hermosillo.

REFERENCES CITED

Abbott, David R., Andrew D. Lack, Alexa M. Smith, and Henry D. Wallace

2012 A Manual and Graphical Guide for the Hohokam Decorated Ceramics from the Middle Gila River Valley: Towards a Systematic Approach to Hohokam Pottery Classification. *Journal of Arizona Archaeology* 2(1):51–79.

Abrego Rivas, Alejandra

2014 Análisis de materiales arqueológicos. In *Proyecto La Playa (SON:F:10:3), XIV Informe, Temporada 2013–2014*, edited by M. Elisa Villalpando, John P. Carpenter, and James T. Watson, pp. 36–64. Centro INAH Sonora, Hermosillo.

Abrego Rivas, Alejandra, Emmanuel Alejandro Gómez Ambríz, and Cinthya Isabel Vidal Aldana

2016 Excavacion de la Unidad 2016. In *Proyecto La Playa (SON:F10:3): Informe 2015–2016*, edited by M. Elisa Villalpando, John P. Carpenter, and James T. Watson, pp. 31–63. Centro INAH Sonora, Hermosillo.

Bernal Gutiérrez, Laura

2005 Análisis de la Cerámica. In *Proyecto Arqueológico La Playa, VII Informe, Temporada 2004, Análisis de los Materiales Arqueológicos*, edited by M. Elisa Villalpando Canchola and John P. Carpenter, pp. 26–54. Centro INAH Sonora, Hermosillo.

Bowen, Thomas

1972 A Survey and Re-evaluation of the Trincheras Culture, Sonora, Mexico. Manuscript on file, Arizona State Museum, Tucson.

1976 *Seri Prehistory: The Archaeology of the Central Coast of Sonora, Mexico*. Anthropological Papers of the University of Arizona, Number 27. The University of Arizona Press, Tucson.

Braniff Cornejo, Beatríz

1992 *La Frontera Protohistórica Pima-Ópata en Sonora, México*. 3 vols. Instituto Nacional de Antropología e Historia, Mexico City.

Cajigas, Rachel

2019 Human Modifications to Sonoran Desert Landscapes During the Early Agricultural Period: Geoarchaeological Investigations at Tumamoc, Hill, Arizona, U.S.A. and La Playa, Sonora, Mexico. PhD dissertation, Department of Geosciences, University of Arizona, Tucson.

Carpenter, John, Guadalupe Sánchez, James Watson, and Elisa Villalpando

2015 The La Playa Archaeological Project: Binational Interdisciplinary Research on Long-Term Human Adaptation in the Sonoran Desert. *Journal of the Southwest* 10(2–3):213–264.

Carpenter, John, Guadalupe Sánchez, and Ismael Sánchez

2018 The Archaic Period in Sonora. In *The Archaic Southwest: Foragers in an Arid Land*, edited by Bradley J. Vierra, pp. 98–118. The University of Utah Press, Salt Lake City.

Carpenter, John P., María Elisa Villalpando, and Guadalupe Sánchez Miranda

2009 La Playa: An Early Agricultural Period Landscape. *Archaeology Southwest* 23(1):14.

Chiykowski, Tanya

2016 Gendered Movement and Changing Ceramics at Cerro de Trincheras, Sonora, Mexico. PhD dissertation, Department of Anthropology, Binghamton University, Binghamton, New York.

Claypatch, Hunter M.

2018 Indigenous Pottery from Sonora, Mexico. Examining Typologies and Spatial Distribution. Master's thesis, Department of Anthropology, Binghamton University, Binghamton, New York.

Douglas, John E., and César A. Quijada

2004 Between the Casas Grandes and the Río Sonora Valleys: Chronology and Settlement in the Upper Bavispe Drainage. In *Surveying the Archaeology of Northwest Mexico*, edited by Gillian E. Newell and Emiliano Gallaga, pp. 93–109. University of Utah Press, Salt Lake City.

Doyel, David E.

1977 *Excavations in the Middle Santa Cruz River Valley, Southeastern Arizona*. Contribution to Highway Salvage Archaeology in Arizona, Number 44. Arizona State Museum, Tucson.

Ezell, Paul E.

1954 An Archaeological Survey of Northwestern Papagueria. *Kiva* 19(2/4):1–26.

Gladwin, Winifred and Harold S. Gladwin

1929 *The Red-on-Buff Culture of the Papagueria*. Medallion Papers No. 4. Gila Pueblo, Globe, Arizona.

Gallaga Murrieta, Emiliano

1997 Analisis de la Ceramica Policroma del Sitio

Cerro de Trincheras, Sonora, Mexico. Tesis de Licenciatura en Arquología, Escuela Nacional de Antropología e Historia, Mexico City.

Gómez Ambríz, Emmanuel Alejandro, Cinthya Isabel Vidal Aldana, and Alejandra Abrego Rivas
2016 Análisis de los materiales arqueológicos: Cerámica. In *Proyecto La Playa (SON:F10:3): Informe 2015–2016*, edited by M. Elisa Villalpando, John P. Carpenter, and James T. Watson, pp. 115–127. Centro INAH Sonora, Hermosillo.

Haury, Emil W.
1937 Pottery Types at Snaketown. In *Excavations at Snaketown I: Material Culture*, edited by Harold S. Gladwin, Emil W. Haury, E.B. Sayles, and Nora Gladwin, pp. 169–229. Medallion Papers No. 25, Gila Pueblo, Globe, Arizona.

1976 *The Hohokam: Desert Farmers & Craftsmen: Snaketown, 1964–1965*, University of Arizona Press, Tucson.

Heckman, Robert A.
2001 Ceramics at El Macayo. In *El Macayo: A Prehistoric Settlement in the Upper Santa Cruz River Valley*, edited by William L. Deaver and Carla R. Van West, pp. 73–93. Statistical Research, Tucson.

Hinton, Thomas B.
1955 A Survey of Archaeological Sites in the Alter Valley, Sonora. *Kiva* 21(1/2):1–12.

Johnson, Alfred E.
1960 The Place of the Trincheras Culture of Northern Sonora in Southwestern Archaeology. Master's thesis, Department of Anthropology, University of Arizona, Tucson.

Macías, Samira
2012 Restauración de los Elementos 64A y 113 de "Loma de Las Cremaciones." In *Proyecto Institucional Trincheras: Informe 2011*, edited by M. Elisa Villalpando, pp. 281–296. Centro INAH Sonora, Hermosillo.

McBrinn, Maxine E., and Laurie D. Webster
2008 Creating an Archaeology without Borders. In *Archaeology Without Borders: Contact, Commerce, and Change in the U.S. Southwest and Northwestern Mexico*, edited by Laurie D. Webster and Maxine E. McBrinn, pp. 1–22. University Press of Colorado, Boulder.

McGuire, Randall H., and María Elisa Villalpando C.
1993 *An Archaeological Survey of the Altar Valley, Sonora, Mexico*. Arizona State Museum Archaeological Series 184. University of Arizona, Tucson.

2011 Introduction. In *Excavations at Cerro de Trincheras, Sonora, México*, edited by Randall H. McGuire and Elisa Villalpando, pp.1–40. Arizona State Museum Archaeological Series 204. University of Arizona, Tucson.

2015 War and Defense on Cerros de Trincheras in Sonora, México. *American Antiquity* 80(3):429–450.

Morales Monroy, Juan Jorge
2006 Las Arenas de La Playa (SON F: 10: 3): Estudio de Composición Ceramica. Tesis de Licenciatura en Antropología, Especialidad Arqueología. Universidad de las Américas, Puebla.

Montgomery, Barbara K., and William L. Deaver
2000 Ceramics. In *Archaeological Investigations at Aldea Inesperada, Site AZ EE:9:175 (ASM): A Prehistoric Settlement Located on the Hohokam/Trincheras Frontier, North of Nogales, Santa Cruz County, Arizona*, edited by Scott M. Kwiatkowski, pp. 133–235. Archaeological Reserch Services, Tempe.

Ownby, Mary F., and Matts Myhrman
2020 Investigations into the Production of Broadline Purple-on-red Pottery from the Tucson Basin. *Kiva* 86:372–395.

Pastrana, Mayela and M. Elisa Villalpando
2002 Análisis de Concha. In *Proyecto Arqueologico La Playa (SON F:10:3): Cuarto Informe Temporada Verano 2001 y Propuesta para la Temporada Verano 2002*, edited by John P. Carpenter, Guadalupe Sánchez, and M. Elisa Villalpando, pp. 149–166. Centro INAH Sonora, Hermosillo.

Reinhard, Karl J., and Jeff H. Shipman
1978 Prehistoric Cremations from Nogales, Arizona. *Kiva* 43(3/4):231–252.

Rincón M., Sahira
2010 Materiales Diagnosticos Recolectados en Superficie. In *Proyecto La Playa [SON F:10:3], Informe de la Temporada 2009*, edited by M. Elisa Villalpando Canchola, John P. Carpenter, and James Watson, pp. 39–65. Centro INAH Sonora, Hermosillo.

Santoyo, Melisa
2011 Análisis de Materiales: Cerámica. In *Proyecto La Playa, SON F:10:3, Informe de Trabajo 2010–2011*, edited by M. Elisa Villalpando, John P. Carpenter, and James T. Watson, pp. 55–62. Centro INAH Sonora, Hermosillo.

Sauer, Carl and Donald Brand
1931 *Prehistoric Settlements of Sonora, with Special References to Cerros de Trincheras*. University of California Publications in Geography 5(3). University of California Press, Berkeley.

Schiffer, Michael B.
1986 Radiocarbon Dating and the "Old Wood" Problem: The Case of the Hohokam Chronology. *Journal of Archaeological Science* 13(1):13–30.

Villalpando Canchola, María Elisa
2007 La Cerámica de Sonora. In *La Producción Alfarera en el México Antiguo, Volume IV*, edited by Beatriz Leonor Merino Carrión and Ángel García Cook, pp. 251–272. Colección Científica, Instituto Nacional de Anthropología e Historia, Mexico City.

2012 *Proyecto Institucional Trincheras: Informe 2011*. Centro INAH Sonora, Hermosillo.

Villalpando Canchola, María Elisa, and John P. Carpenter
2005 *Proyecto Arqueológico La Playa: VII Informe, Temporada 2004*. Análisis de los Materiales Arqueológicos. Centro INAH Sonora, Hermosillo.

Villalpando Canchola, María Elisa, John P. Carpenter, and James T. Watson
2018 *Proyecto La Playa (SON:F:10:3): Informe 2016–2017*. Centro INAH Sonora, Hermosillo.

Wallace, Henry D.
2004 Update to the Middle Gila Buff Ware Ceramic Sequence. In *Hohokam Farming on the Salt River Flood-plain: Refining Models and Analytical Methods*, edited by T. Kathleen Henderson, pp. 45–124. Anthropological Papers No. 43. Center for Desert Archaeology, Tucson.

Watson, James T.
2011 Bioarchaeology of the First Farmers in the Sonoran Desert. In *The Latest Research on the Earliest Farmers*, edited by Sarah A. Herr, pp. 1–11. Archaeology Southwest Online Publications. www.archaeologysouthwest.org/what-we-do/investigations/earliest-farmers, accessed July 30,2020.

SUPPLEMENTAL MATERIAL

Typological Description for La Playa Purple-on-brown

La Playa Purple-on-brown

Cultural Affiliation: Trincheras tradition

Temporal Range: Pre-700 CE to undetermined

Manufacture: Coil-and-scrape

Paint: Mineral (Hematite). Seldom specular. Paint color is referred to as "purple" but is typically 2.5YR 3/1 (dark reddish gray), 2.5YR 3/2 (dusky red), or 2.5YR 2.5/1 (reddish black).

Slip: None.

Thickness: 4.4mm (Average).

Exterior Surface: This ceramic type is generally hard and well polished. The surface color is variable but typically ranges from 2.5YR 5/6 (Red) to 7.5YR 5/4 (Brown).

Interior Surface: Interior scraping occurs on all olla and seed jar body sherds. Scraping is typically fine lined and bold.

Body Motifs: The two most frequent motifs are a checkerboard and rake pattern motif. The checkerboard motif resembles a modern gaming board and appears in several varieties—including a solid checkerboard, a parallel band checkerboard, and a diamond checkerboard. The rake pattern motif consists of groups of thin parallel lines. This motif bears similarities to the scraping found on vessel interiors. Additional motifs have been observed, however, they remain uncommon.

Rim Motifs: Two rim motifs have been observed: one consisting of short tick marks running parallel to the rim and another with long, thin, linear bands extending perpendicular to the rim. Line execution is variable; however, many motifs are fine lined.

Paste and Inclusions: Fine-to-medium paste that is typically gray-to-reddish gray in color. Igneous rock and quartz are the most common inclusions. Mica has also been observed.

Vessel Forms: Of the 47 sherds identified as La Playa Purple-on-brown, the majority (71.7%) were body portions of either ollas or seed jars. The remaining sherds were identified as: 10.8% (olla), 8.6% (seed jar), 4.3% (bowls), and 4.3% (handles).

Geographic Distribution: This type has been primarily documented from the site of La Playa (SON F:10:03) along the *Río Boquillas* in northern Sonora. Additional sherds have been documented in the Altar Valley.

Type Example: No complete vessel of La Playa Purple-on-brown is known. Seven refitting sherds from bag number 18232 at *Los Montículos*, La Playa (SON F:10:03) provide the largest known vessel fragment associated with this type (see Figure 4). This olla, or seed jar, body fragment possesses a rake pattern motif, is 14.5 cm wide and 3.8 mm thick.

Comments: Excavations from La Playa (SON F:10:03) currently suggests that La Playa Purple-on-brown was primarily produced prior to 700 CE. This type can be distinguished from Trincheras Purple-on-brown by its distinct motifs, thin vessel walls, and limited use of specular paint. This type also lacks a thickened rim, or "fat lip," which is typical on many Trincheras seed jars.

Two sherds (one from SON F:10:03 and another from SON F:02:82) possess a red slip (2.5YR 3/6). Aside from application of a red slip, these sherds are morphologically and stylistically identical to La Playa Purple-on-brown. It is possible that future research may necessitate the introduction of "La Playa Purple-on-red." In the meantime, these sherds should be interpreted as unusual varieties of La Playa Purple-on-brown.

INSIGHTS INTO ELEVENTH AND TWELFTH CENTURY CULTURAL PROCESSES AS REVEALED THROUGH DIGITAL RERECORDING AND IN-FIELD CERAMIC ANALYSIS OF THE NORTHERNMOST ARIZONA BALLCOURTS

Crispin Wilson

Formalized ballcourt structures in the Southwest are a material remnant of a social phenomenon stretching from the Mesoamerican world throughout Mexico and into the Hohokam sphere of southern and central Arizona. This paper focuses on the 17 northernmost known ballcourts, with a digital rerecording of fifteen of them, and uses legacy data for Winona and Wupatki ballcourts. To re-record the northern Arizona ballcourts, I employed aerial photography in the form of an unmanned aerial vehicle (UAV) mounted high-resolution digital camera as well as a pole-mounted Canon EOS 6D digital camera. Aerial photos were ortho-corrected with survey grade real time kinematic Global Navigation Satellite Systems (RTK GNSS) technology and combined into photogrammetric models to produce digital elevation models (DEMs), orthophotos, and 3D models. Combined with ceramic analyses to determine use periods and cultural affiliation, these models provide new insights into how the northernmost ballcourts may have facilitated local and regional cultural processes in the eleventh and twelfth centuries CE (unless otherwise noted, all dates are CE). Specifically, reassessing the northern ballcourt network using such technology exposed previously unnoticed patterns in ballcourt orientation and construction methods, indicating that ballcourts may have both facilitated integration of culturally diverse communities along cultural frontiers and reaffirmed group identity in less diverse heartland settings.

PREVIOUS RESEARCH

Accounts from Spanish conquistadores and the Catholic friars sent to convert Indigenous populations of the New World describe ball games throughout the Caribbean, Central and South America, and Mexico in the fifteenth century (Stern 1949). Apart from the ethnographic evidence following first contact between Europeans and Native Americans, there exists material evidence in the form of Mayan codices, carved reliefs, and clay figurines depicting the ballgame. Evidence that formal ballcourts were connected with cultural, material, and political power exists throughout their geographic distribution. The earliest example of a formal ballcourt, which is understood to belong to the Mokaya cultural tradition (Clarke and Poe 2011), is found at Paso de la Amada in Chiapas, Mexico, dating to approximately 3600 BP. Accordingly, the ceremonial ballgame was associated with the first hierarchical complex societies in the Americas. Some archaeologists interpret the headgear featured on the monolithic carved stone heads of Olmec leaders as leather helmets associated with the ballgame (Hill and Clark 2001).

In recent years, Sonora, Mexico has seen a resurgence in popularity of the sport known as Ulama, in which a heavy rubber ball is kept in play using the hip or forearm (depending on which local version of the scoring system is followed). Ulama is derived from the Aztec version of the Mesoamerican ballgame which was all but stamped out following European subjugation of Central American indigenous cultures' ritual and religious practices, to which the ballgame was significant (Leyenaar 2001). The Ulama hip game is just one example of several different kinds of ballgames played in precontact Mesoamerica. Wall murals and ceramic figurines depict ballplayers using wooden bats, stone paddles known as handstones, as well as their hips and hands as means of manipulating rubber, wooden, or stone balls (Blomster 2012; Day 2001; Taladoire 2001:112). At the Tres Alamos site in southeastern Arizona, 69 stone paddles were located in association with the ballcourt, suggesting they were components of the ballgame which occurred there (Tuthill 1947:41-42).

The archaeological community was not aware of the presence of ballcourts outside of Mesoamerica and the Caribbean until the mid-1930s. During excavations at Snaketown, a regional hub for the ancestral Hohokam community located 25 miles southeast of Phoenix, Arizona, Emil Haury (1976) proposed his hypothesis that the ovular, bowl-shaped, earthen structures found throughout the Hohokam sphere were in fact ballcourts,

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representative of a variation of the Mesoamerican ballgame. The courts excavated by Haury featured plastered interiors, center court stone markers, and entrances at each end. Unlike in Mesoamerica, however, there were no material representations of the ballgame such as carved reliefs or clay figurines in association with Haury's discoveries. In fact, material or ethnographic representations of the ball game have yet to be identified in the American Southwest with the exception of a small number of ceramic figurines believed to represent ballplayers found in southern Arizona (Wilcox and Sternberg 1983; Thomas and King 1985). Based on the discovery of a few rubber balls in the Hohokam region, Haury (1976) hypothesized that Hohokam ballcourts are a material remnant of the Mesoamerican ballgame that spread northward into the American Southwest. With confirmation from leading experts at the time such as Alfred Kidder, Sylvanus Morely, and William Duncan Strong, Haury's hypothesis became widely accepted within the archaeological community. The Mesoamerican connection to the Hohokam of southern Arizona proposed by Haury (1976) was a significant change in thinking because, until that time, Southwest archaeology considered the Puebloan-Anasazi tradition of the Four Corners region to be the dominant cultural influence in the Southwest (Wilcox and Sternberg 1983:28-31).

After visiting the Snaketown excavation in 1935, John C. McGregor returned to northern Arizona with a piqued interest in the bowl-shaped depressions associated with several large archaeological sites north and east of Flagstaff. Working for the Museum of Northern Arizona under Harold Colton, McGregor went on to excavate the Winona ballcourt at Winona Village (NA 2132) east of Flagstaff, and to test Juniper Terrace, Wupatki, and both courts at Ridge Ruin. McGregor found patterns within the known northern Arizona courts of the time. He noted,

> Thus a generalized type of Northern Arizona ball court may be established. They are all oval, open, partially excavated structures, with a flat, or nearly flat, playing floor. All of the seven thus far located are almost of exactly the same size, averaging about ninety feet long, and half that wide through the center. Markers of some sort occur in, or just below, the floor, either in the center, or at the ends on the center line. The center stone, if present, is so accurately located, and the length, and length to breadth ratio, so accurately measured, that some sort of measuring device, perhaps a cord, is certainly suggested. The general oval form is, in most cases, so accurately made that it too suggests accurate measures. In all cases but one the main axis is nearly north and south, the exception is approximately east and west (McGregor 1937:18).

Here, McGregor recognized the ovular Hohokam style of ballcourt unique to the southwest and distinguished it from the rectangular, enclosed, semi-enclosed, and open ballcourts of Mesoamerica (Taladoire 2001). Such morphological differences have led to varying interpretations of the Hohokam ballcourts; Ferdon (1967) argued the structures may have served as dance plazas and Wilcox (1991:124) suggested Hohokam ballcourt morphology may have developed independently of Mesoamerican ballcourt architectural styles. Along with architectural design, ballcourt orientation has been addressed in past research (McGuire 1987; Teague 1989; Wasley and Johnson 1965:82-83; Wilcox and Sternberg 1983). However, Marshall (2001:12) pointed out that past studies of ballcourt orientation have suffered from methodological inconsistencies.

More recent Southwest ballcourt research has provided date ranges for many of the northern ballcourts and determined them to have been the venues for intra- and intercultural feasting events and exchange (Morales 1994; Weintraub 2008). Material exchange, particularly of trade goods such as ceramics, may have been an important function of precontact Southwest ballcourts (Abbott 2010; Abbott et al. 2007) and thereby helped integrate geographically separate groups of people. Several ballcourts of this study, such as Wagner Hill and Doney Park, are located along prehistoric travel routes and may have facilitated the exchange of materials such as Government Mountain obsidian from Cohonina-controlled territory to neighboring populations to the south and east (Bostwick 2020:655; Bryce and Bailey 2015:137; Kellett 2020; Shackley 2005).

Ballcourts are also understood to have been a means of easing societal tensions and helping displaced people reorganize within a new territory. In reference to the effect that the Sunset Crater eruption may have had on the Sinagua population living within the ashfall zone, O'Hara suggested that "means of integration, mediation, and sharing provided by ballcourt use also likely played a significant role in assisting affected populations adjust to the impacts of loss of productive lands and the resettlement of refugees" (2015:493). Ballcourts likely facilitated precontact populations during periods of societal and environmental flux such as the twelfth century abandonment of the Cohonina heartland, eruption of Sunset Crater in the latter half of the eleventh century, and subsequent periods of drought, by potentially bringing people together in "friendly competition and peaceful exchange" (O'Hara 2015:486).

Interestingly, O'Hara believes that in the Flagstaff area, ballcourt use was polythetic in the sense that ballcourts functioned differently between heartland and frontier zone settings. As indicated by ceramics present in and around the courts, ballcourts such as Doney Park, New Caves, and Old Caves likely predate the eruption of Sunset Crater. O'Hara linked the construction and use of these three ballcourts to an influx of Cohonina migrants into the frontier zone around Deadmans Wash south of Wupatki. Tensions may have arisen as migrant groups settled in the area, likely due to competition for territory and resources. O'Hara suggested that the construction of the Doney Park ballcourt may have been in response to social and cultural tensions which had been building along the frontier zone between the local Sinagua population and Cohonina settlers towards the end of the tenth and into the early eleventh century. O'Hara's inferences of cultural affiliation are based on proportions of plainware ceramics (see Colton 1946), which some (e.g., Elson et al. 2011:207) have rejected in favor of a more exchange-based model of ceramic circulation. The other two pre-eruptive ballcourts may have functioned more for the integration of local Sinagua populations, as they are set closer to the heartland than the frontier, and the dominate ceramic ware at these courts is Alameda Brown ware. It should also be noted that San Francisco Mountain Gray ware sherds occur within every northern Arizona ballcourt ceramic assemblage.

THE CURRENT STUDY

Morales's (1994) thesis research was the last intensive study of the northern Hohokam style ballcourts. In the past 25 years, digital technology has greatly advanced and has become widely available and affordable. This research employs modern technology in the form of high-resolution UAV photogrammetry to compare an expanded sample of the northern ballcourts, while including updated ceramic analysis from ballcourt sites with uncertain use periods to better understand temporal associations. Prior to this study, I hypothesized that modern recording methods would reveal aspects of ballcourts invisible to previous researchers and improve our comprehension of ballcourt morphology and significance of spatial orientation.

TECHNOLOGY EMPLOYED

Aerial Photography and Photogrammetry

The use of aerial photography is not new to Southwest archaeology. Interestingly, Anne and Charles Lindbergh, at the request of Dr. Alfred Kidder, conducted flyovers at renowned archaeological sites such as Canyon de Chelly and Chaco Canyon in the late 1920s, collecting aerial photographs (Cochrane 2016; McBrinn 2015). Today, high resolution aerial photography, in conjunction with modern Global Navigation Satellite Systems (GNSS) technology and computer software, has become an economically and logistically viable method of recording and monitoring archaeological sites. The past 15 years has seen considerable advancement of remote sensing and digital technology, allowing accurate modeling of objects and landscapes. Previously, such technologies were cost prohibitive and required the expertise of specialists (Fernández-Hernandez et al. 2015)

High-resolution, digital aerial photography has the potential to improve archaeological site recording. Computer software allows construction of DEMs, orthomosaics, and 3D models that help archaeologists to map and examine archaeological sites (Mead 2018). In the case of prehistoric ballcourts, DEMs are particularly well suited for measurement and comparison of court structure because such models allow the viewer to visualize the depth of courts as well as the height of their berms within the context of the larger landscape from which the ballcourt was constructed

Traditionally, handheld compasses are the tool used in the field to record orientation of any archaeological feature. Although the trusty Brunton is still standard equipment for many archaeologists, measurements with a magnetic compass can be inaccurate and subjective. For example, measurements of orientation of the northern ballcourt network are typically listed as 'generally north-south' or 'slightly east of north' and are rarely compared with other ballcourts. Creating ortho-correct digital models of the northern ballcourts and arraying them with a geographic information system (GIS) allows for the detection of patterns within the northern ballcourt network and the inference of possible associations within and between ballcourt communities.

The UAV used in this research was a DJI Mavic 2 Pro equipped with a Hassleblad wide angle camera. This piece of equipment was vital to the successful outcome of my project as I found later that the spatial data collected by the drone provided highly accurate measurements without the heavy, bulky, and temperamental RTK GNSS rover and base station. A more efficient compromise which would ensure accurate recording of spatial data is a UAV with onboard RTK or a Post-Processed Kinematic (PPK) receiver. In this way, the step of collecting coordinates with the RTK rover would be eliminated, and spatial data would be collected at the same time as aerial photographs.

Global Navigation Satellite Systems

Global Navigation Satellite Systems (GNSS) have proven essential in archaeological fieldwork since they became widely available in the early 2000s. The value of such systems lies in the ability of the archeologist to record accurate spatial information in the field with a handheld device, made possible through satellite communication. When combined with photogrammetry, high-precision GNSS technology allows for the creation of accurate models through the georeferencing of ground control points (GCPs; Mead 2018).

GCPs are visual markers captured in aerial photographs which can then be associated with centimeter-accurate[1] GNSS coordinates. RTK and PPK GNSS coordinates contain *x*, *y*, and *z* values that, when added to photogrammetric models, create three-dimensional, digital models that are precisely measurable and retain the spatial orientation of the actual features recorded in the field. Agisoft Metashape Professional (2020) is the software that I used to combine photographs and GNSS points from the field in this research.

RTK vs. Traditional GNSS Receivers

The primary difference between RTK and traditional standalone GNSS receivers is that, because RTK technology uses two receivers—the stationary base unit and the mobile rover unit, the system is capable of identifying distortions in satellite signals as they move through the atmosphere and ionosphere. In this manner, this base unit calculates the level of distortion and communicates these corrections to the mobile rover unit. Thus, when conditions are right, the RTK GNSS system is capable of centimeter-accurate positions, while traditional standalone GNSS units such as a Trimble, Garmin, or smartphone record points and polygons that have closer to two-to-four-meter accuracy for lack of position corrections

DATA COLLECTION

Fieldwork comprised a major component of this study, in combination with the use of preexisting data, particularly the surface artifact analysis and mapping techniques of Morales (1994). Setup of the RTK GNSS base station, arrangement of ground control targets for aerial photography, and collection of RTK GNSS points using the Emlid Reach RS rover unit encompassed the majority of time spent at each site. UAV photography was accomplished after the RTK base station was in place and recording RINEX files because the base station requires a minimum of two hours of RINEX file recording for optimal accuracy. On the Kaibab National Forest and at courts where vegetation presented a threat to comprehensive UAV photography, I used a pole-mounted digital camera to ensure thorough photographic coverage of the ground surface in and around the ballcourt sites.

Identification of Ballcourts in the Study

The 15 ballcourts recorded in this study include all of the known Arizona ballcourts under study in Morales' (1994) thesis work, with the addition of Porter and Loflin, as well as five other courts in the Williams area associated with the Cohonina culture (Figure 1). The structures included in this study were previously designated as ballcourts by land managers and scholars familiar with ballcourt identification. A goal of this research was to compile data on all the remaining northern Arizona ballcourts and potentially discern and explain morphological differences between courts according to their respective contexts.

Field Recording

Tall vegetation such as ponderosa pine and juniper trees obscuring the ground surface of the site areas, particularly on and within the courts, proved to be a significant obstacle for the use of UAV photography. If a ballcourt was open and not obscured by vegetation, I would typically make passes with the UAV, south to north and again north to south, taking as many photographs of the ballcourt area as was necessary to achieve 30-50% overlap of the area defined by four ground control points placed in each corner of the ballcourt area. Often for the more open, less vegetated courts, I would vary the altitude of the UAV between passes. I quickly discovered that for courts with many trees growing in and around them, it was necessary to photograph the courts from as many angles and altitudes as possible to find an unobstructed view of the ground surface. This was undertaken to create an accurate recording of the vegetation in order to later classify and remove vegetative points during data processing. For some ballcourts, such as Doney Park, New Caves, and the Williams courts, this proved impossible because flying the drone close to trees with the collision avoidance feature turned off quickly became untenable due to the obvious crash risk and potential damage to the aircraft. At Juniper Terrace, located under high-voltage powerlines, I had to fly at an altitude of 10 m for photographic transects to avoid the powerlines and possible electrical arc to the UAV. At other courts, particularly on the Kaibab National Forest, a pole-mounted camera was used in place of the UAV due to dense vegetation and research permitting concerns of forest managers.

Postprocessing

The primary goal of this research was to record and analyze ballcourt structures in a new way (photogrammetry and 3D modelling) in order to capture the current condition of the courts and allow objective comparison between courts. Data regarding court size

1 Centimeter-accurate measurement is possible for horizontal measurements. Vertical measurements are less accurate.

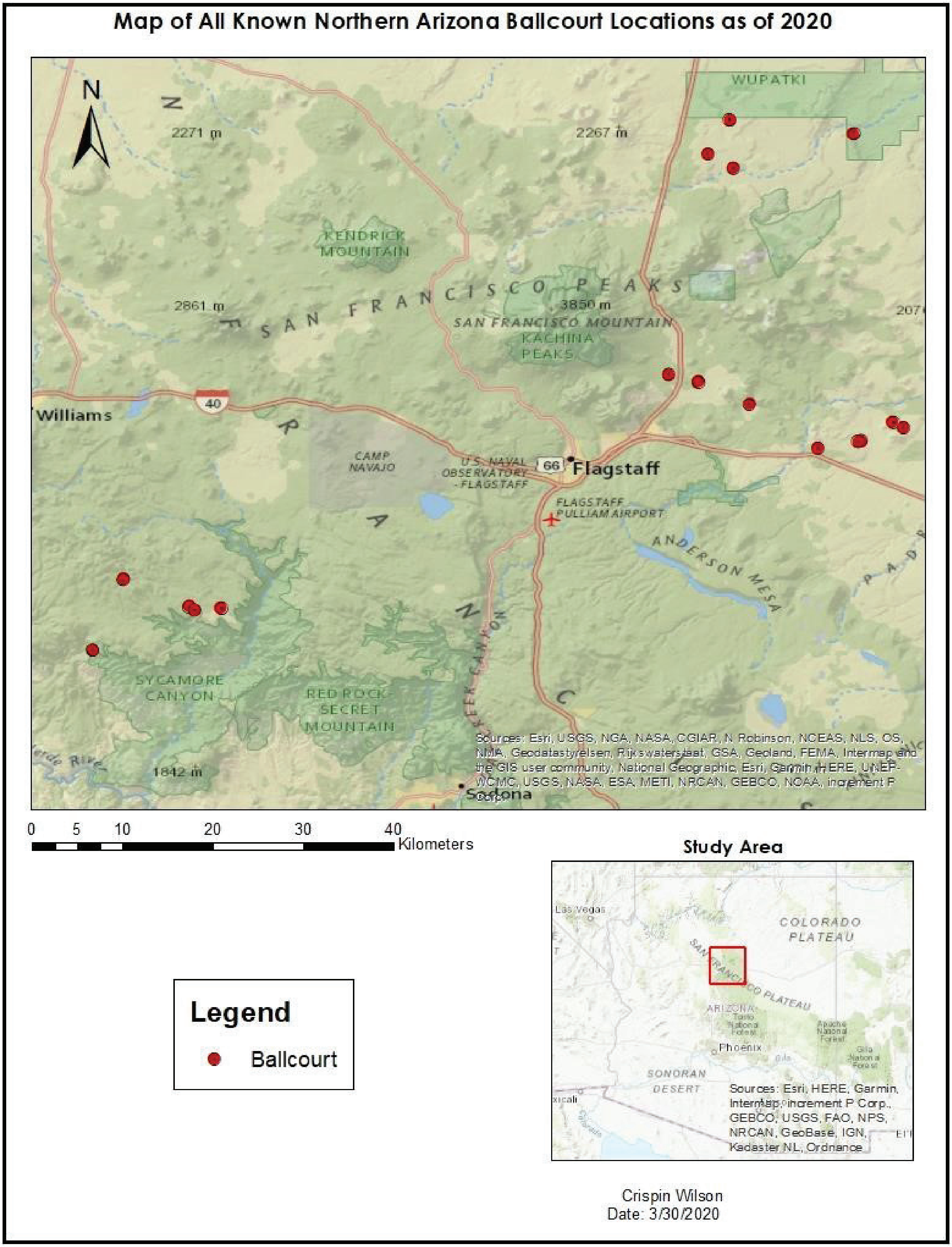

FIGURE 1. Map of all 17 of the northern Arizona ballcourts. The Winona and Wupatki ballcourts are included on this map though not digitally rerecorded as part of the study. The Winona ballcourt was obliterated in 1976 and the Wupatki ballcourt was reconstructed by the National Park Service in 1965.

and orientation have been collected in past studies. I compared these values using the digital models from field data collection to assess the accuracy and utility of the technology employed in this research and to look for inconsistencies between traditional and digital measurements. Current software programs, such as Agisoft Metashape, ArcGIS, and Pix4D, allow forms of measurement which were previously impossible in the field. For example, after a ballcourt model and DEM has been created using Agisoft Metashape, measurement tools allow for the volume of the interior and berms of the now proportionally correct DEM to be calculated to within a fraction of a cubic meter. Such tools allow estimates of construction time and the size of the workforce required to build a ballcourt.

Measuring Berm Volume

To measure a model, I used the draw polygon, polyline, point, and patch tools in Metashape on the DEMs. Using the color-coded DEM to determine the highest points of the berm, a polygon can be drawn across the top. This polygon rests on the digital ground surface, and once drawn, Metashape calculates values for the volume above, below, and the total volume in relation to the polygon. For example, in order to calculate the volume of a berm, I located the exterior of the berm using the DEM. Many of the ballcourts in this study, especially the Flagstaff courts, have well defined berms, the extents of which are made clear in the color transition of the DEM. This process is somewhat subjective, but to allow consistency and conservative volume measurements, I first digitally removed surface vegetation from the model and then centered measurement polygons on the outside of the transition from the natural ground surface to the upward slope of the berm exterior. This measurement does not account for material lost from approximately 900 years of wind and water erosion but does give the present volume of the berms to within a few cubic meters.

Measuring Ballcourt Orientation

To determine the orientation of the ballcourts, I exported the spatially corrected DEMs into ArcGIS and measured the orientation of each court using the COGO report tool. Ballcourt orientation can be a subjective measurement to record in the field as the shape and middle of the structures can be hard to determine on the ground. To record ballcourt orientation, I used a north azimuth measurement scale and took the average of 10 measurements for each court. I chose this method for measuring ballcourt orientation because even when using digital models, finding the middle of the long axis is somewhat subjective. By averaging orientation measurements, subjectivity is minimized (Figure 2).

FINDINGS

The following discussion of my research findings addresses ballcourt morphology in temporal, spatial, and cultural contexts. I also discuss the challenges and advantages of the technology employed in this study and how the environmental conditions at each site affected the use of the UAV, RTK GNSS, and pole-mounted Canon EOS 6D camera. For more information concerning how the technology used facilitates detection and monitoring of adverse impacts to archaeological sites through three-dimensional (3D) imaging, see Wilson (2020).

My research investigated how recent technological methods of recording influence our knowledge and conceptions of ballcourts and how this technology aids us in uncovering past human processes relating to ballcourts. Another area of inquiry was whether there was existing evidence that supports the function of ballcourts to bring both discrete and adjoining cultural groups together to reaffirm and renegotiate relationships between and within geographic territories.

In the following pages, I refer to JD Wash (AR-03-07-01-1398), Sycamore Point (AR-03-07-07-127), Round Mountain (AR-03-07-01-1323), Butler (AR-03-07-01-2269), and Wagner Hill (AR-03-07-01-1398) as the Cohonina or Williams courts, which all have a predominance of San Francisco Mountain Grey ware. The remaining ballcourts comprise the Flagstaff area courts, split into heartland and frontier zone contexts based on the geographic location and dominant ceramic wares present at the courts. Juniper Terrace (NA 804), Wupatki Road (NA 1893), Second Sink (NA 3254), and Doney Park (NA 4008) comprise the frontier zone courts. The Sinagua heartland courts are New Caves (NA 5212), Old Caves (NA 72), Ridge Ruin East (NA 3669), Ridge Ruin West (NA 3687), Porter (NA 3342), and Loflin (NA 15349).

Ballcourt Orientation

In this section, the possible significance of ballcourt orientation is discussed. The discussion is divided between the Flagstaff and Williams study areas.

Flagstaff Ballcourts

During the data processing phase of this project, patterns of ballcourt morphology and orientation in relation to ceramic dates and cultural affiliation began to emerge. First, among the Flagstaff ballcourts, there appears to be matched orientation between contemporaneous courts in geographic proximity to one another relative to cultural affiliation (Table 1). Matched sets of contemporaneous courts recorded in this study include Old Caves and New Caves, the Ridge Ruin courts, Porter and Loflin, and Juniper Terrace and Wupatki Road

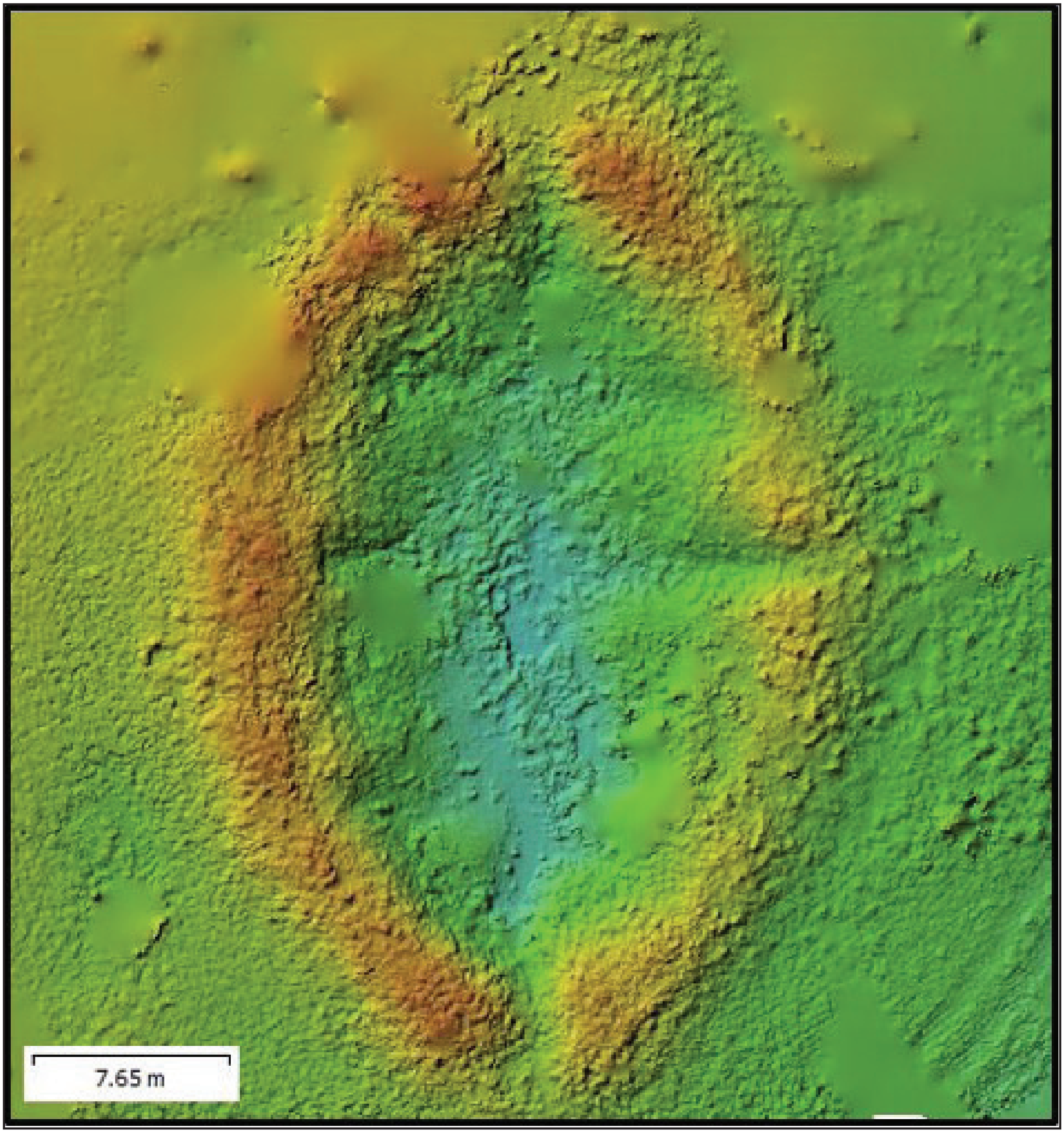

FIGURE 2. Digital Elevation Model (DEM) of the Juniper Terrace Ballcourt. The linear depressions visible within the ballcourt are remnants of John McGregor's 1936 test trenches. Recent tire tracks are visible in the right hand corner of the Table. One of the benefits of such DEMs is the detection and recording of modern threats to archaeological resources such as cattle trampling, illegal excavation, and off-roading.

(Figure 3). The most variation in orientation between two courts of a "set" are New Caves at 31.5° and Old Caves at 45° with a difference of 13.5°. This set is unique in the sense that it constitutes the only two ballcourts of the Flagstaff group oriented east of true north. These are also the earliest ballcourts in the Flagstaff area, both dating to the mid-eleventh century; they are within close proximity, at 5.5 km on the east and west ends of Doney Park, which was an important area for resource procurement for the Sinagua.

Of the Flagstaff ballcourt group, among the frontier zone ballcourts, it seems likely that Wupatki Road,

Table 1. Classification of the 15 Ballcourts Recorded in this Study

Setting	Ballcourt	Mean Ceramic Date	Volume Berm (m³)	Volume Interior (m³)	Orientation (azimuth; °)	Length (m)	Width (m)
Frontier Zone Cohonina	JD Wash	1091[a]	8	7	9	27.3	13.3
	Sycamore Point	1069[a]	23.7	23.2	276	32.1	13.7
	Round Mountain	1093[a]	N/A	N/A	~40[b]	45-50[b]	20-30[b]
	Butler	1032[a]	N/A	N/A	349[b]	49[b]	25[b]
	Wagner Hill	1130[a]	80.25	63.6	289.5	30.2	14.5
Frontier/Mixed Affiliation	Juniper Terrace	1145	156.6	363.9	.5	32.3	20.5
	Wupatki Road	1130	129.7	149.9	8	31.8	19.8
	Second Sink	1109	213.3	221.9	3.5	35.6	21.7
	Doney Park	1108[d]	602.5	275	357.5	34.1	20.5
Sinagua Heartland	New Caves	1046[c]	425	301.5	31.5	32.9	22.3
	Old Caves	1035	231.4	254.4	45	31.1	21.1
	Ridge Ruin East	1110	533.4	496.5	335	40.4	28.7
	Ridge Ruin West	1104	246.2	432.2	341	42.3	26.1
	Porter	1116	245.8	254.4	7	35.7	22.3
	Loflin	1112	176.6	108.7	7	26.9	18.5

Note: All dates are AD.
a From Weintraub (2008).
b From Kaibab National Forest (KNF) site form.
c Pre-1064 ceramics present potentially indicate a mid-eleventh century construction date; intrusive later ceramics present may have pushed the mean ceramic date later than the true period of use.
d Mean ceramic date calculated using all sherds from all sources (Morales [1994] data and Downum [personal communication, 2019–2020] data).

Juniper Terrace, and the Wupatki ballcourt represent a set of three courts. The Wupatki ballcourt is oriented north–south as the other two courts are, is in proximity, and was presumably built later than A.D. 1140 as determined by a Flagstaff Black-on-White style sherd found under the ballcourt during excavation (C. Downum, personal correspondence, March 7, 2020; Lindsay 1965). If the ceramic dates from Wupatki Road, Juniper Terrace, and Wupatki are accurate, then the three courts may have been among the latest active in the Southwest which include several ballcourts in the Phoenix Basin and Verde Valley (C. Downum, personal correspondence, March 7, 2020; Wilcox 1991; Wallace 2014). Among the Sinagua heartland ballcourts in this study, it also seems likely that the Winona ballcourt, now destroyed, may have been part of a set of three along with the two Ridge Ruin courts. The Winona ballcourt dates to the early twelfth century with an orientation approximately 20° west of north and is located approximately 3.75 km from Ridge Ruin (McGregor 1937).

Correlations between the ceramic dates, orientation, and proximity between these pairs of ballcourts suggest that such matching ballcourts were temporally associated with each other, possibly constructed by the same architects, and possibly for the purpose of hosting reciprocal social and ritual events between neighboring communities. The addition of the Porter and Loflin ballcourts to this study, not included in past research, provides a new set of courts, each the closest court to the other, with matching orientations, and overlapping use periods as determined by large surface ceramic assemblages. Remarkably, there are two sets of contemporaneous ballcourts within the Sinagua heartland designation. Ceramic dates indicate that (1) the Winona, Ridge Ruin East, Ridge Ruin West, and (2) the Porter and Loflin ballcourts form sets that were all constructed

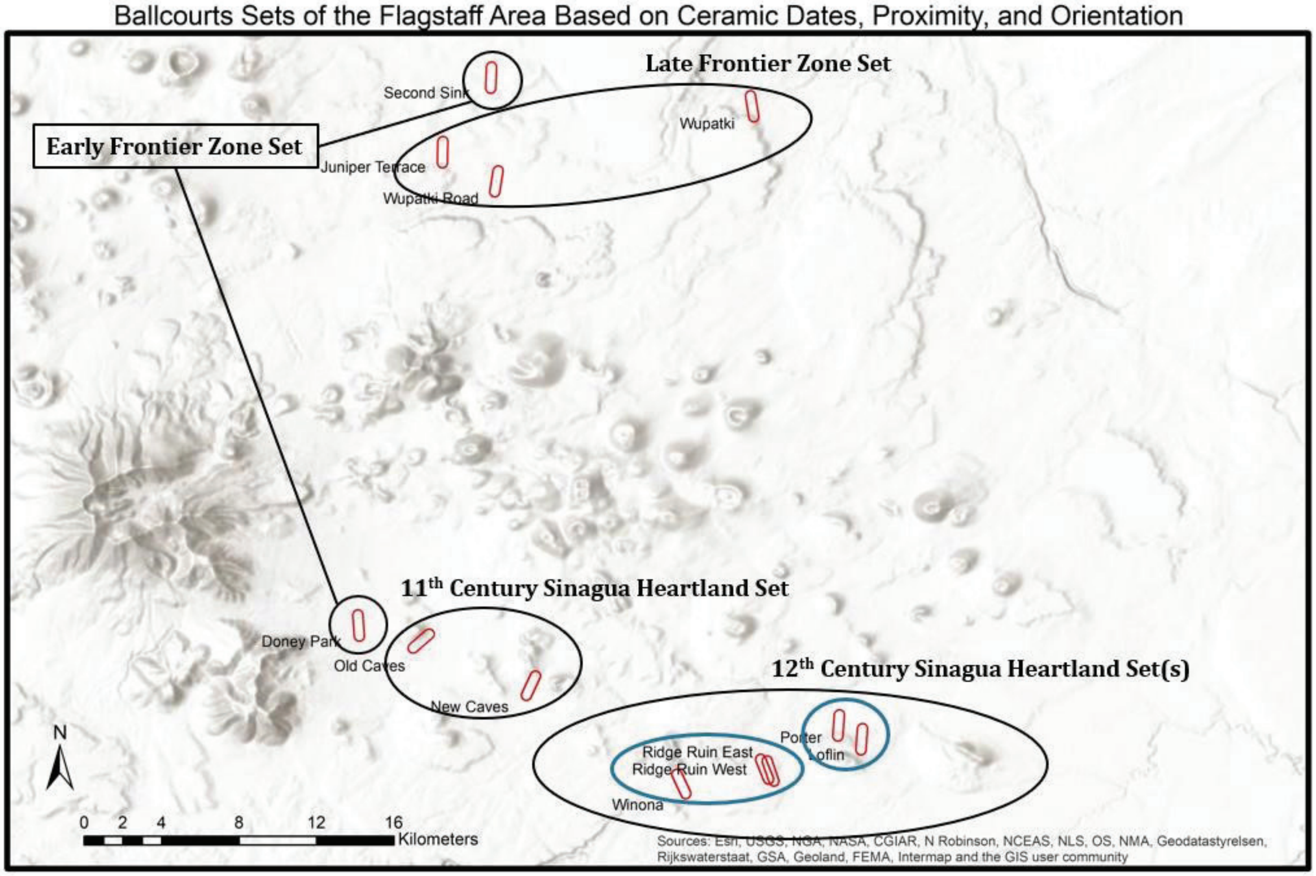

FIGURE 3. Map of possible ballcourt sets of the Flagstaff study area. The blue ovals in the twelfth Century Sinagua Heartland set demarcate the Winona-Ridge Ruin set and the Porter-Loflin set. Although contemporaneous, the distinctive orientation between the ballcourts of these respective communities could indicate different group identity or responsibility within the larger Sinagua population. The following dates were determined using the mean ceramic dating formulas described in Christianson (1994) and Weintraub (2008) with surface sherds for all ballcourts except Winona and Wupatki. Legacy data (Lindsay 1965, McGregor 1937) was used for the Wupatki and Winona ballcourts. Chronologically, these sets begin with the eleventh Century Sinagua Heartland Set of Old Caves (1035) and New Caves (1046); followed by the Early Frontier Zone Set of Doney Park (1108) and Second Sink (1109); the concurrent twelfth Century Sinagua Heartland Sets of Winona (1113), Ridge Ruin East (1110), Ridge Ruin West (1104), and the Porter-Loflin subset of Porter (1116), and Loflin (1112); and the Late Frontier Zone Set of Juniper Terrace (1145), Wupatki Road (1130), and Wupatki Ballcourt (Post-1140).

around the same time and were all in use during the first two decades of the twelfth century. The Winona-Ridge Ruin set (total of three ballcourts) features west of north orientation of all three ballcourts of the set. The Porter-Loflin set features north-south orientation. Each of these ballcourts is within a closer proximity to the other court(s) in their set than to any other ballcourt in the study area. These two contemporary sets with markedly distinctive ballcourt orientation could indicate different groups, possibly religious or secular societies trusted with aspects of a ritual cycle or calendar, which existed within the greater Sinagua population (Table 2).

Recent comprehensive surface ceramic analysis from pit house communities associated with the Doney Park ballcourt conducted by Downum in 2019 and 2020 now support a post-eruptive use period for the ballcourt. Morales' (1994) sample of fewer than 40 sherds suggested a pre-eruptive date based on the presence of Rio de Flag Brown. Upon closer inspection, however, these sherds may in fact have been Deadmans Gray, oxidized and discolored from exposure to countless fire events and stained by the reddish-brown soil of the Ponderosa pine forest where the ballcourt is located. New ceramic evidence, based on fresh exposures of sherd temper that were not possible in 1994, suggests that the Doney Park ballcourt was constructed following the Sunset Crater eruption in the late eleventh century. This ballcourt may have functioned in a frontier setting to accommodate an influx of Cohonina migrants from the west (Downum and Sullivan 1990; Weintraub et al. 2006), possibly drawn to new subsistence opportunities resulting from the mulching effect of the Sunset eruption ash and cinder fall (Pilles 1978,1979). The north-south orientation of the Doney Park ballcourt echoes

Table 2. Ceramic Scatter and Pit House Depressions 55 m east of Doney Park Ballcourt (Mean Ceramic Date 1104 AD).

Ceramic Type	No. of sherds
Black Mesa B/W	2
Dogoszhi B/W	1
Tusayan Corrugated	16
Rio de Flag Brown	9
Winona / Angell Brown	187
Deadmans Gray / Deadmans Fugitive Red	78
Total	293

all other ballcourts with mixed ceramic assemblages in frontier areas. The location of the Doney Park ballcourt along Shultz Pass, a known prehistoric trail for populations on both sides of the San Francisco Peaks and Mt. Elden, further supports a frontier/mixed affiliation designation for the ballcourt. This idea is reinforced by substantial quantities of both Alameda Brown ware and San Francisco Mountain Gray ware (see Table 2). Therefore, Doney Park and Second Sink were ostensibly an early (twelfth century) frontier/mixed ceramic assemblage set. Second Sink ballcourt in the northern frontier zone may have accommodated a mixed population arriving from the north and west into the preexisting Alameda Brown ware-using population. While at Shultz Pass, Doney Park may have helped to integrate people from the west resettling in traditionally Alameda Brown ware-using populations east of the San Francisco Peaks and facilitated exchange of Government Mountain obsidian (Kellett 2020). As the frontier area north of present-day Flagstaff shifted east and Wupatki became a regional hub, the later frontier set of Wupatki Road, Juniper Terrace, and Wupatki ballcourts were constructed in part to mitigate tensions of a mixed population who were exchanging materials and likely competing for the same agricultural resources (Stone and Downum 1999).

This research seems to support some of O'Hara's (2015) theoretical assertions regarding possible societal roles of ballcourts in the Flagstaff area, except for the new finding that Doney Park was a post-eruptive frontier zone ballcourt. Meanwhile, within the Sinagua heartland, there is potential evidence for Sinagua clan or sodality identity expressed through ballcourt orientation. The idea of paired ballcourt networks or sets seems to be a strong possibility among the Flagstaff ballcourts but more evidence from southern ballcourt networks could help determine if this theory applies outside of the northern ballcourt network

Williams Ballcourts

The Cohonina or Williams ballcourts also exhibit meaningful patterns of orientation (see Figure 3), although due to the incomplete dataset from Kaibab National Forest, these conclusions are tentative and would benefit from further research. The Wagner Hill and Sycamore Point ballcourts, although nearly 8.5 miles apart, share a similar west of north orientation with Sycamore at 276° and Wagner Hill at 289.5°. Such close orientations could indicate that the Wagner Hill and Sycamore Point courts comprise a set in the same manner as the ballcourts in the Flagstaff area. According to mean ceramic dates from the 2008 PIT Project (Weintraub 2008), the courts' use periods overlapped. Mean ceramic data places the Sycamore Point court use period between AD 1029-1109 and the Wagner Hill court to AD 1090-1170. The other three ballcourts measured on Kaibab National Forest do not share similar orientations. The Butler ballcourt was oriented slightly west of north at 349°, JD Wash approximately north-south at 9°, and Round Mountain east of north at approximately 40°. Butler and JD Wash are within 685 m of one another; if these two did indeed represent a pair, the discrepancy in size and orientation between them would be unexpected. It seems possible, given the ephemeral nature of the Williams ballcourts, that more courts have yet to be located and recorded on Kaibab and Prescott National Forests. Further study of Cohonina social spaces, activity areas, and possible dance floors may provide insights into the Butler and Round Mountain ballcourts because these two features are only analogous to one another when compared to the rest of the ballcourts of this study

Accurate recording of ballcourt orientation in relation to geographic and temporal data of ballcourt networks could shed light on how communities used these structures and possibly how orientation indicates cosmological significance. Wilcox and Sternberg (1983) note that, at the time of writing, orientation had only been recorded for 66 of 193 known ballcourts, and measurements were usually recorded in the field with magnetic compasses. The authors went on to suggest that ballcourt orientation could have been associated with annual cycles of calendrical events and corresponding ceremonies, and they suggested the significance of ballcourt orientation as an avenue for future study. Their 1983 work, although primarily on Hohokam ballcourts of southern Arizona, theorized the formation of "contrast sets" (212) between and among contemporaneous ballcourt communities which may have facilitated exchange of resources and ceremonial participation. Ballcourt orientation may also have been associated with particular ceremonial rights of each respective ballcourt community. Ceremonies may have alternated between communities following calendrical, astronomical, or ritual cycles, in a manner facilitating ceremonial participation of the entire population.

Ballcourt Construction

3D modeling allowed digital reconstruction of the ballcourts, making possible precise measurement of berm and interior volume. By measuring and comparing ballcourts between and within ceramically defined cultural contexts, I found patterns suggesting possible construction methods and cultural markers. Many of the ballcourts of this study are located on slightly sloping terrain. A naturally sloping ground surface allowed the ballcourt builders to more easily excavate a pit which would become the ballcourt interior. Material removed from the pit was placed downslope to form the downslope berm. This construction method is evidenced in the DEMs, which often indicate a slight depression, always outside of the upslope berm (Figure 4). At the Ridge Ruin West, Ridge Ruin East, Loflin, Porter, and Wagner Hill courts where this was observed, soil was excavated by the builders of the ballcourt and moved downslope to form the berm. The downslope berm appears to have been constructed using soil from what would become the ballcourt interior.

Analyzing the ballcourt DEMs across geographical areas dominated by different plain ware ceramics allows inference of how ballcourt morphology may also reflect cultural identities and provides insights into societal organization between cultures. Based on DEM measurements, there appears to be a significant difference in the volume of the berms between ballcourts having predominantly Alameda Brown ware surface ceramic assemblages and those with mostly San Francisco Mountain Gray ware pottery. Berms of ballcourts west of the San Francisco Peaks, exhibiting overwhelmingly San Francisco Mountain Gray ware sherds, have much lower, less substantial berms than ballcourts east of the peaks with mostly Alameda Brown ware. Even the large, later frontier zone ballcourts (Juniper Terrace, Wupatki Road, and Second Sink) have narrower berms than the Sinagua heartland courts to the south. Several Cohonina courts, i.e., those west of the peaks, are also

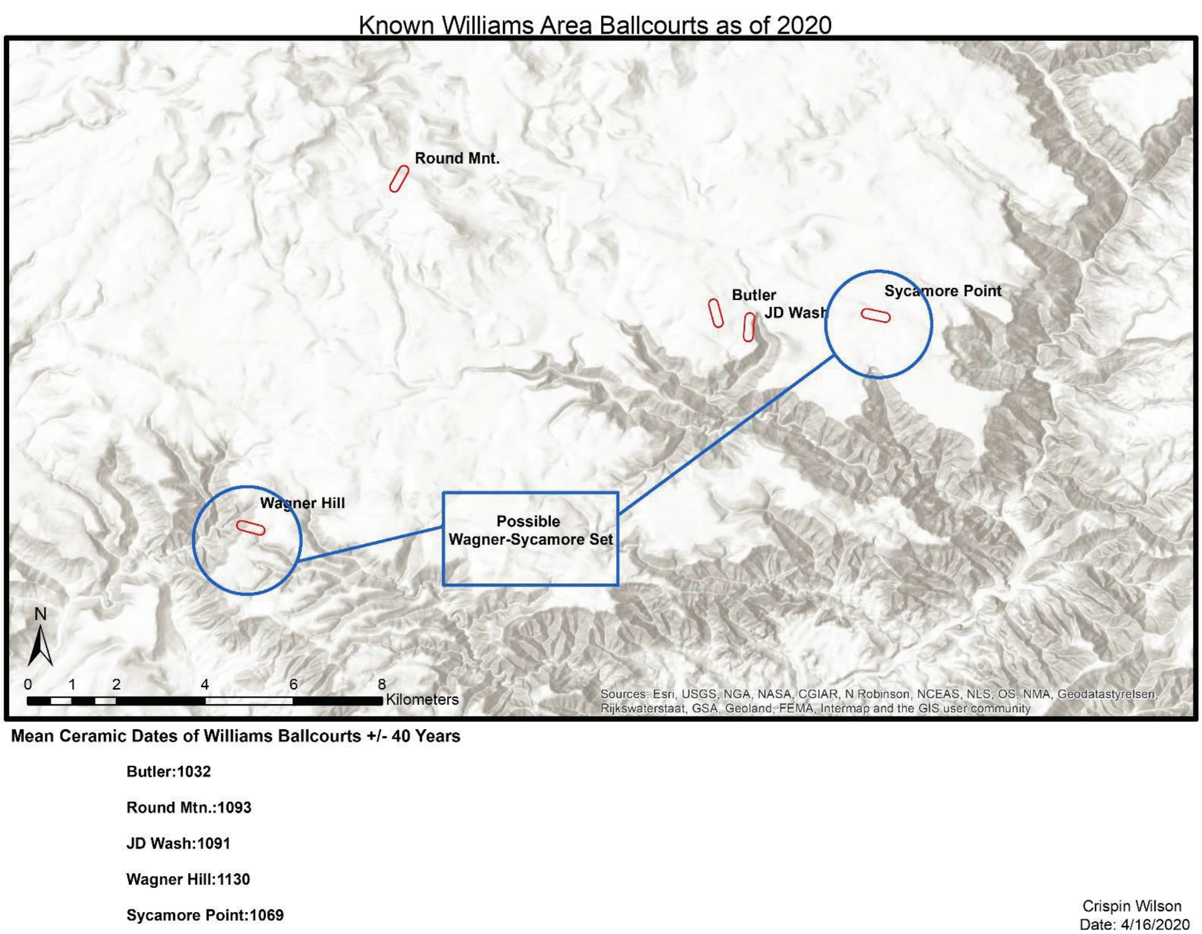

FIGURE 4. Map showing possible Sycamore-Wagner set based on orientation and mean ceramic dates. For more information regarding mean ceramic dating of San Francisco Mountain Gray Ware see Weintraub (2008) and Sorrel (2005). Mean ceramic dates (+/- 40 years) of the Williams area ballcourts are Wagner Hill (1130), Sycamore Point (1069), JD Wash (1091), Round Mountain (1093), and Butler (1032).

Table 3. Average Berm Volume Among Ceramically Defined Cultures

Ceramically Defined Culture	Average Volume of Berm	Sample Size	Standard Deviation	Range
Sinagua	309.70 m3	6	138.90	108.7-496.5
Mixed-Flagstaff frontier zone	275.52 m3	4	220.75	129.7-602.5
Cohonina	37.32 m3	3	38.00	8-8.25

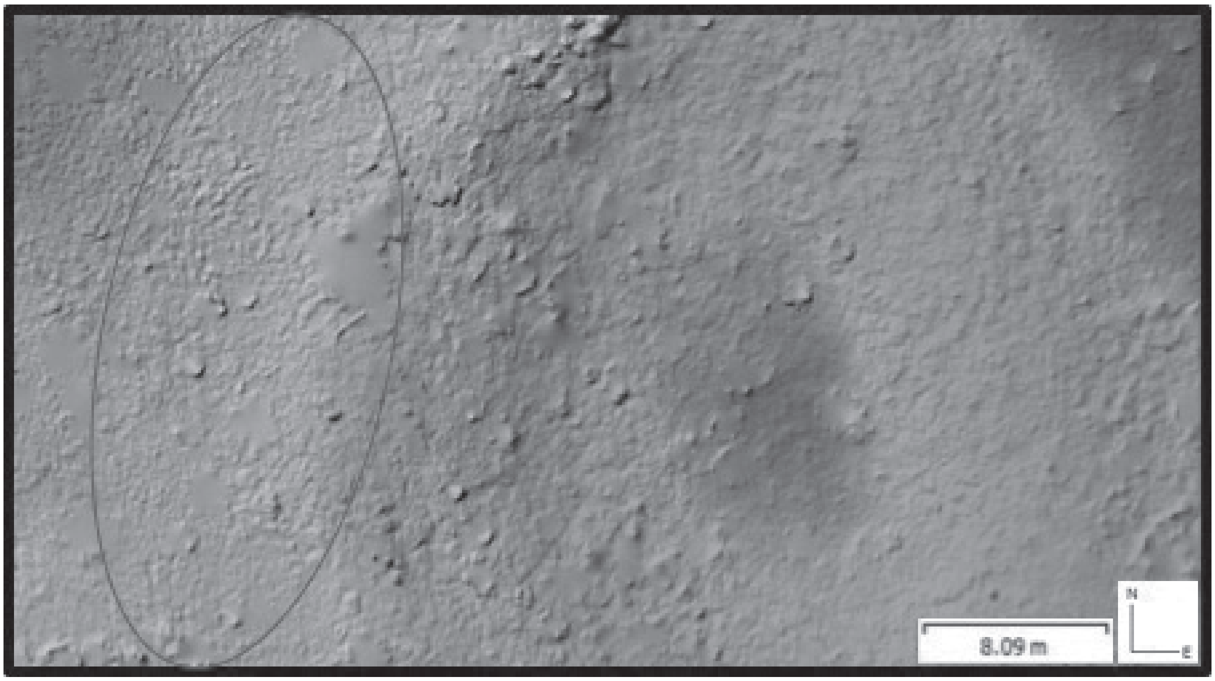

FIGURE 5. DEM of Ridge Ruin West ballcourt. The left side of the image is the higher side of the ballcourt as indicated by warmer colors. The faint depression along the west berm, outlined by the red oval, indicates excavation occurred on the outside of the berm as well as what would become the ballcourt interior.

quite oblong when compared to the rounder, more elliptical Sinagua ballcourts, i.e., those east of the peaks and south of the frontier zone. Also, several Cohonina courts' interiors match the elevation of the ground surface surrounding the ballcourt, showing no or few signs of excavation (Table 3, Figure 5).

Such differences could have several implications. First, some Cohonina groups are considered to have been a less sedentary, more transient society who followed resources across the landscape seasonally (McGregor 1951). Conversely, archaeological evidence suggests that the Northern Sinagua stayed within a more defined territory and were more reliant on agriculture than their Cohonina neighbors to the west. Organizing the labor to excavate and construct a ballcourt would have required considerable resources and an established community capable of overseeing such a project (see Craig et al. 1998:252). Based on the previously mentioned patterns of ballcourt orientation and the relative uniformity of ballcourt dimensions, it seems that precise orientation and site selection were determining factors in ballcourt construction. Such determinations may have served to mark the ballcourt as belonging to a particular community or culture while impressing upon visitors the architectural capability of the builders. Ballcourts of the Flagstaff frontier zone, where nearly equal distributions of Alameda Brown ware and San Francisco Mountain Gray ware are found, exhibit characteristics of both the Sinagua and Cohonina heartland ballcourts. This finding suggests that frontier zone courts may have been constructed by mixed communities of populations originating from areas east and west of the San Francisco peaks, as they appear to be combinations of the two distinctive building styles. Evidence of intercultural cooperation strengthens the theory that ballcourts may have functioned in part as arenas of social integration.

Regardless of what we might infer from the morphological differences between Sinagua, Cohonina, and mixed affiliation ballcourts, it seems that the structures may have played an important role in social identity, community development, as well as local and regional trade and cooperation between and within groups of the prehistoric Southwest

The Utility of Photogrammetry and 3D Modeling

Digital modeling of the northern Arizona ballcourts has allowed an unprecedented level of comparison of ballcourt morphology and orientation, while high-resolution aerial photography illuminates impacts that threaten these unique archaeological features.

UAV vs. Pole Camera Photography

High-resolution digital aerial photography was a critical component of this research. Aerial photos allow the entire ballcourt and surrounding ground surface to be photographed in a matter of minutes compared to several hours for pole-mounted camera photography. The size of the ballcourt area in most cases was approximately 50 × 50 m and often largely covered in vegetation. To adequately photograph such a large area using a pole camera to achieve 40% overlap between images requires two people and significantly more time than UAV photography. I also found that the software used to combine photographs was more likely to accept UAV photographs than those from the pole-mounted digital camera. I assume the lower height of the pole camera shots made it difficult for the software to put the photos into context, especially where the surface of the ground was covered with a homogenous layer such as a blanket of pine needles. The UAV allows total coverage of the area being recorded because photos can be taken from numerous heights and angles when the ground surface is obscured by vegetation. This allows for better perspective and increases the chances that the photos will successfully align in the modeling software.

Portability is another advantage of UAV photography. The UAV used in this research was a DJI Mavic 2 Pro which folds up and fits into a hard case for transportation to the field. Other than batteries and the remote controller (combined with a smartphone), all of the components required to use the UAV fit neatly into the case which fits easily into a backpack. I found the pole camera to be a much less portable system in the field. Because I used an RTK GNSS system to record the coordinates of my GCPs, I was already carrying a large metal tripod for the base unit and a Trimble two-meter survey pole for the rover unit. The addition of an extendable camera pole became a burden for one person, especially when the ballcourt location required more than a kilometer or so hike from the vehicle. Also, the camera used for pole camera photography, a Canon EOS 6D, is a considerably more expensive and fragile piece of equipment than the UAV. Overall, the UAV proved more portable, easier for one person to use, faster, and produced better quality results than the pole-mounted camera.

Limitations

The main limitation to this research was my inability to create useful models of the Round Mountain and Butler structures. This difficulty was in part due to the size of the structures as well as the density of woody vegetation growing on and within them. What made recording the Butler and Round Mountain sites so difficult was that my permit from the Kaibab National Forest did not allow the use of the UAV without a research permit that specifically allowed UAV usage. Attempting to photograph a heavily vegetated 3,000 m^2 area with the pole camera proved to be unworkable. To properly document and create models of the Butler and Round Mountain structures using photogrammetric techniques will require many UAV photographs from different heights and angles so that all the trees and shrubs within the court area may be digitally classified and removed. Based on the lab results from the two sites, I do not think it is possible to achieve sufficient coverage using a pole camera alone. The RTK GNSS system was also troublesome at times but fortunately the spatial data captured by the UAV was more than adequate for the creation of centimeter-accurate digital models.

Practical Implications

There are several implications to this research. First, we now have a better understanding of the northern Arizona ballcourts including their exact size, shape, orientation, and use periods. Second, we have found that shared orientation between many of the northern Arizona ballcourts seems to indicate contemporaneous sets, which suggests possible calendrical, ceremonial significance between respective ballcourt communities. Third, we can make inferences into possible ballcourt construction techniques made discernible through photogrammetric 3D models. And finally, we have tested and determined the utility of RTK GNSS, UAV aerial photography, and 3D modeling software to record, measure, and compare archaeological features as well as locate and determine the severity of impacts to archaeological sites.

Future Research

Continued research of the northern Arizona ballcourts should include thorough recording and documentation of all other features at the site other than the ballcourts themselves. There appears to be a wide range of habitations in association with the courts, ranging from multiroom pueblos such as the Rattlesnake Pueblo near the

Porter ballcourt, to pithouse hamlets like those found near the Loflin and Doney Park ballcourts, to a combination of the two as at the main Juniper Terrace site. Dating of such structures to determine if they were contemporaneous with ballcourt dates would be central to the study. Also, the creation of measurable digital models for the Butler and Round Mountain ballcourts on Kaibab National Forest would improve these data, especially with regard to the possible cultural implications of berm volume. Subsurface testing of features described as ballcourts on Kaibab National Forest could confirm the presence of plaster and/or stone markers, thereby supporting the idea that such features are in fact large Cohonina ballcourts.

Comprehensively testing the accuracy of using the UAV alone to create photogrammetric models without using the RTK GNSS system could be of value. Free smartphone apps, such as Avenza Maps, could provide backup coordinates for GCPs and would greatly expedite recording and data processing time. If centimeter-accurate models are consistently producible without RTK GNSS data, then the cumbersome and time-consuming RTK GNSS equipment can stay at the lab, and time and money could be saved in future archaeological projects.

An expansion of this study to include ballcourt systems in the Verde and Prescott Valleys of north-central Arizona would also be useful in determining how the Southern Sinagua and Prescott culture ballcourts may compare to the northern counterparts. Dating and comparing ballcourt size and orientation could reveal possible cosmological and social significance of the structures. A closer examination of artifact and architectural types from ballcourts belonging to orientational sets, as defined in this study, might shed light on possible differences between such sets.

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REFERENCES CITED

Abbott, David R.
2010 The Rise and Demise of Marketplace Exchange among the Prehistoric Hohokam of Arizona. In *Archaeological Approaches to Market Exchange in Ancient Societies*, edited by Christopher Garraty and Barbara L. Stark, pp. 61–83. University Press of Colorado, Boulder.

Abbott, David R., Alexa M. Smith, and Emiliano Gallaga
2007 Ballcourts and Ceramics: The Case for Hohokam Marketplaces in the Arizona Desert. *American Antiquity* 72:461–484.

Agisoft Metashape Professional (Version 1.6.2) (Software)
2020 Retrieved from http://www.agisoft.com/downloads/installer/.

Blomster, Jeffrey P.
2012 Early Evidence of the Ballgame in Oaxaca, Mexico. *Proceedings of the National Academy of Sciences of the United States of America* 109(21): 8020–8025.

Bostwick, Todd W
2020 *The Dyck Cliff Dwelling: A Sinagua Habitation Site Overlooking Beaver Creek, Central Arizona*. Verde Valley Archaeology Center Occasional Papers No. 2, Camp Verde, Arizona.

Bryce, William D., and Ashlee M. Bailey
2015 Bifacial Lithic Technology at Tuzigoot and Montezuma Castle National Monuments: A Southern Sinagua Case Study. *Journal of Arizona Archaeology* 3 (1 and 2):130–143.

Clarke, John E., and Mary E. Poe
2011 Revisiting the Mixe-Zoque: A Brief History of the Preclassic Peoples of Chiapas. In *The Southern Maya in the Late Preclassic: The Rise and Fall of an Early Mesoamerican Civilization*, edited by Michael Love and Jonathan Kaplan, pp. 25–46. University Press of Colorado, Boulder.

Cochrane, Dorothy
2016 Pioneering Aerial Archaeology by Charles

and Anne Lindbergh. https://airandspace.si.edu/stories/editorial/pioneering-aerial-archaeology-charles-and-anne-lindbergh, accessed on October 1, 2019.

Colton, Harold S.
1946 *The Sinagua: A Summary of the Archaeology of the Region of Flagstaff, Arizona*. Northern Arizona Society of Science and Art, Flagstaff.

Craig, Douglas B., James P. Holmlund, and Jeffrey J. Clark
1998 Labor Investment and Organization in Platform Mound Construction: A Case Study from the Tonto Basin of Central Arizona. *Journal of Field Archaeology* 25(3):245–259.

Day, Jane Stevenson
2001 Performing on the Court. In *The Sport of Life and Death: The Mesoamerican Ballgame*, edited by E. Michael Whittington, pp. 65-77. Thames & Hudson, New York.

Downum, Christian E., and Allan P. Sullivan III
1990 Settlement Patterns. In *The Wupatki Archaeological Inventory Survey Project: Final Report*, compiled by B. A. Anderson, pp. 5.1–5.90. Professional Paper No. 35. Southwest Cultural Resources Center, Division of Anthropology, National Park Service, Santa Fe.

Elson, Mark D., Michael H. Ort, Kirk C. Anderson, James M. Heidke, Paul R. Shepard, and Terry L. Samples
2011 In the Shadow of the Volcano: Prehistoric Settlement in the U.S. 89 Project Area. In *Sunset Crater Archaeology: The History of a Volcanic Landscape*, edited by Mark D. Elson, pp. 187–211. Anthropological Papers No. 37, Center for Desert Archaeology, Tucson, Arizona.

Ferdon, Edwin N., Jr.
1967 The Hohokam "Ball Court": An Alternative View of its Function. *Kiva* 33(1):1–14.

Fernández-Hernandez, Jesus, Diego Gonzalez-Aguilera, Pablo Rodriguez-Gonzalvez, and Juan Mancera-Taboada
2015 Image-based Modeling from Unmanned Aerial Vehicle (UAV) Photogrammetry: An Effective, Low Cost Tool for Archaeological Applications. *Archaeometry* 57(1):128–145.

Haury, Emil W.
1976 *The Hohokam: Desert Farmers & Craftsmen: Excavations at Snaketown 1964–1965*. The University of Arizona Press, Tucson.

Hill, Warren D., and John E. Clark
2001 Sports, Gambling, and Government: America's First Social Compact? *American Anthropologist* 103(2):331–345.

Kellett, Michael S.
2020 Prehistoric Obsidian Procurement and Exchange in West-Central Arizona. Master's thesis. Department of Anthropology, Northern Arizona University, Flagstaff.

Leyenaar, Ted
2001 The Modern Ballgames of Sinaloa: A Survival of the Aztec Ullamalitzli. In *The Sport of Life and Death: The Mesoamerican Ballgame*, edited by E. Michael Whittingham, pp. 97–115. Thames and Hudson, New York.

Lindsay, Alexander J., Jr.
1965 Preliminary Report on Excavations at the Wupatki Ball Court. Wupatki National Monument, Arizona.

Marshall, John T.
2001 Hohokam Regional Ballcourt Data. In *The Grewe Archaeological Research Project, Vol. 1: Project Background and Feature Descriptions*, edited by Douglas B. Craig, pp. 571–585 Anthropological Papers No. 99-1, Northland Research, Flagstaff, Arizona.

McBrinn, Maxine
2015 *Oblique Views: Aerial Photography and Southwest Archaeology*. Museum of New Mexico Press, Santa Fe.

Mead, Kent
2018 Low-Cost UAV Photogrammetry: An Application for Archaeological Survey in the Upper Gila River Watershed, New Mexico. Master's thesis, School of Anthropology, University of Arizona, Tucson.

McGregor, John C.
1937 Winona Village: A XIIth Century Settlement with a Ball Court Near Flagstaff, Arizona. *Museum of Northern Arizona, Bulletin No. 12*. Northern Arizona Society of Science and Art, Flagstaff 1951 *Cohonina Culture.* University of Illinois Press, Urbana.

McGuire, Randall H.
1987 *Death, Society, and Ideology in a Hohokam Community: Colonial and Sedentary Period Burials from La Ciudad*. Ciudad Monograph Se-

ries No. 6, Office of Cultural Resource Management Report No. 68, Arizona State University, Tempe.

Mead, Kent
2018 Low-Cost UAV Photogrammetry: An Application for Archaeological Survey in the Upper Gila River Watershed, New Mexico. Master's thesis, School of Anthropology, University of Arizona, Tucson.

Morales, Michael, Jr.
1994 Prehistoric Ballcourts in Northern Arizona. Master's thesis, Department of Anthropology, Northern Arizona University, Flagstaff.

O'Hara, Frederick Michael, III
2015 Suyanisqatsi / Koyaanisqatsi: Creating Balance in a Land of Little Water and Burning Rock Cooperation, Competition, and Climate in the Flagstaff Region of the U.S. Southwest A.D. 1000–1300. PhD dissertation, Department of Anthropology, Arizona State University, Phoenix.

Pilles, Peter J., Jr.
1978 The Field House and Sinagua Demography. In *Limited Activity and Occupation Sites: A Collection of Conference Papers*, edited by Albert E. Ward, pp. 119–133. Contributions to Anthropological Studies. Center for Anthropological Studies, Albuquerque, New Mexico.

1979 Sunset Crater and the Sinagua: A New Interpretation. In *Volcanic Activity and Human Ecology*, edited by Payson D. Sheets and Donald K. Grayson, pp. 459–485. Academic Press, New York.

Shackley, M. Steven
2005 *Obsidian: Geology and Archaeology in the North American Southwest*. The University of Arizona Press, Tucson.

Stern, Theodore
1949 The *Rubber-Ball Games of the Americas*. Monographs of the American Ethnological Society No. 17. The University of Washington Press, Seattle.

Stone, Glenn Davis, and Christian E. Downum
1999 Non-Boserupian Ecology and Agricultural Risk: Ethnic Politics and Land Control in the Arid Southwest. *American Anthropological Association* 101(1):113–128.

Taladoire, Eric
2001 The Architectural Background of the Pre-Hispanic Ballgame: An Evolutionary Perspective. In *The Sport of Life and Death: The Mesoamerican Ballgame*, edited by E. Michael Whittington, pp. 97-115. Thames & Hudson, New York.

Teague, Lynn S
1989 Local and Regional Organization and Interaction. In *Hohokam Archaeology Along Phase B of the Tucson Aqueduct, Central Arizona Project, Vol. 1: Synthesis and Conclusions, Part II*, edited by Jon S. Czaplicki and John C. Ravesloot, pp. 277–341. Arizona State Museum Archaeological Series No. 178, Tucson.

Thomas, Charles Matthew, and Jeffrey Howard King
1985 Hohokam Figure Assemblages: A Suggested Ritual Context. In *Proceedings of the 1983 Hohokum Symposium Part II*, edited by Alfred E. Dittert, Jr. and Donald E. Dove. Phoenix Chapter, Arizona Archaeological Society, Occasional Paper Number 2.

Tuthill, Carr
1947 *The Tres Alamos Site on the San Pedro River, Southeastern Arizona*. Archaeology Series No. 4, Amerind Foundation, Inc., Dragoon, Arizona.

Wallace, Henry D.
2014 Appendix D: Ballcourt Data Updates. In *Between Mimbres and Hohokam: Exploring the Archaeology and History of Southeastern Arizona and Southwestern New Mexico*, edited by Henry D. Wallace, pp. 575-590. Desert Archaeology Anthropological Papers No. 52, Tucson, Arizona.

Wasley, William W., and Alfred E. Johnson
1965 *Salvage Archaeology in Painted Rocks Reservoir, Western Arizona.* University of Arizona Anthropological Papers No. 9, Tucson.

Weintraub, Neil
2008 Testing New Field Dating Techniques: Measuring Deadman's Grey Sherd Thickness to Study Cohonina Migration Near Sycamore Canyon PIT Project. In *Passport in Time*. passportintime.com/measuring-deadmans-grey-2008.html.

Weintraub, Neil S., Daniel Sorrell, John Hanson, and Don Christenson
2006 A GIS Model for Late Pueblo II/Cohonina

Multi-directional Migration from the Coconino Plateau. Paper presented at the Petrified Forest Science Symposium, Flagstaff, Arizona.

Wilcox, David R
1991 The Mesoamerican Ballgame in the American Southwest. In *The Mesoamerican Ballgame*, edited by Vernon L. Scarborough and David R. Wilcox, pp. 101–125. University of Arizona Press, Tucson.

Wilcox, David R., and Charles Sternberg
1983 *Hohokam Ballcourts and Their Interpretation*. Archaeological Series No. 1. Cultural Resource Management Division, Arizona State Museum, University of Arizona.

Wilson, Crispin A.
2020 Precontact Northern Arizona Ballcourts as Revealed Through UAV Photogrammetry, GNSS Positioning, and In-Field Ceramic Analysis. Master's thesis, Department of Anthropology, Northern Arizona University, Flagstaff.