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**Recent research  
in commodities  
production and  
exchange, and  
settlement studies**

David Hart  
guest editor

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The *Journal of Arizona Archaeology* is a peer-reviewed journal that focuses on the presentation of emerging ideas, new methods, and current research in Arizona archaeology. It endeavors to be a forum for the scholarly, yet simple communication of research and management related to Arizona's archaeological record. The *Journal* is published twice a year by the Arizona Archaeological Council (AAC) in both electronic and paper formats. At least one issue per year is devoted to the theme of the AAC annual fall conference. The remaining issues of the *Journal* are intended for open submissions. Invited guest editors assist with the compilation of each issue.

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The format of all submitted papers should correspond to the SAA style guide, which can be accessed at this web address: <https://www.saa.org/publications/american-antiquity>. Manuscripts must be submitted as a MS Word document. As all review and editing will be conducted electronically. Authors should be familiar with the "track changes" and "comments" functions of MS Word. Authors are encouraged to contact the editor with questions regarding the content or formatting of their manuscripts prior to submitting their papers. The editor will review each paper prior to peer review to determine if the manuscript meets content and formatting guidelines. If the paper meets these guidelines, the editor will send the manuscript out for peer review. The editor makes the final decision to accept a manuscript on the basis of the reviews of the peer referees. If a manuscript is accepted for publication, authors must submit images in at least 300 dpi. All permissions for photographs and figures are the responsibility of the author and must be obtained prior to publication.

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## THEMED ISSUE:

# RECENT RESEARCH IN COMMODITIES PRODUCTION AND EXCHANGE, AND SETTLEMENT STUDIES

## PREFACE

Dave Hart, Guest Editor

The October 2018 Arizona Archaeological Council Fall Conference at the Arizona History Museum in Tucson, Arizona was focused on a theme of recent research in commodities production and exchange in Arizona archaeology, with an open topic session in the afternoon. We are very fortunate to have included in this issue, three papers from the themed conference, two from open session, and a submission from the call for papers.

Laurene Montero and Todd Bostwick discuss the ceramic evidence for long distance interactions based on analysis of non-local ceramics from Pueblo Grande. Marty Kooistra submitted a paper based on his thesis research on the Arizona Strip where he evaluated the location of Virgin Anasazi habitation sites on Mount Trumbull using cumulative viewshed analysis. Mark Hackbarth's paper from the open topic session is focused on Late Archaic and Early Formative architecture in the Salt River Valley. Chris Loendorf provided an in-depth analysis of obsidian procurement and use within the Phoenix Basin, and Alexandra Covert examined prehistoric marine shell at and Hohokam influence at Wupatki Pueblo from the commodities production and exchange theme. Finally, Dave Bustoz, Mark Hackboarth, Mary Ownby, and Tammy Rittenour provide an analysis of crushed sherd temper in Hohokam ceramics and its potential to refine Hohokam chronology.

I would like to thank each of the authors for contributing to this volume and for their willingness to disseminate the results of their research. It takes considerable effort to prepare presentations and papers for publication. Their contributions are very much appreciated. I would also like to thank the peer reviewers for providing constructive criticism to strengthen each paper, as well as Korri Turner for copy editing, and especially Doug Mitchell for his tireless efforts as editor for the Journal of Arizona Archaeology.

### Erratum

In Spring 2018 issue of the Journal of Arizona Archaeology (vol. 5, no. 2), in the article entitled "Dating Cohonina Archaeological Sites through a Consideration of San Francisco Mountain Gray Ware Thickness: Some Case Studies," by Daniel H. Sorrell, Neil S. Weintraub, and Christian E. Downum, an unfortunate typographical error is included in the equation presented on page 128. The correct equation is:  $y = (136.81)(x^2) + (1600.09)(x) - 3528.90$ . As lead author of this paper, I am responsible for this mistake and offer my apologies to the editorial staff, my co-authors, and the readers.

Sincerely, Daniel H. Sorrell

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# CERAMIC EVIDENCE FOR PREHISTORIC LONG DISTANCE INTERACTIONS: NON-LOCAL CERAMICS FROM AZ U:9:1(ASM) (PUEBLO GRANDE)

Laurene G. Montero  
Todd W. Bostwick

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*Collections of prehistoric nonlocal ceramics indicate that the Hohokam at AZ U:9:1(ASM) (Pueblo Grande) maintained widespread spheres of interaction from southern Utah to northern Mexico. In this paper, ware distributions of nonlocal ceramics collected at Pueblo Grande from depression-era archaeological excavations in the 1930s up to investigations conducted by museum staff in the 1980s are examined. We also compare these data to nonlocal ceramics collected from later excavations at Pueblo Grande as well as those from AZ T:12:10 (ASM) (Las Colinas) and AZ T:12:1 (ASM) (La Ciudad) – two other large Hohokam villages within Canal System 2.*

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The Hohokam are well known for their widespread trade networks, which included a variety of exchange items and strategies and extended for hundreds of miles to many different culture areas (Crown 1991; Doyel 1991; Vokes and Gregory 2007). Pottery was an important component in this trade. This paper presents data on previously unpublished nonlocal pottery from Pueblo Grande Archaeological Park (PG Park) and discusses their significance.

Nonlocal pottery reported in this chapter consists of sherds and a small number of reconstructed vessels that were collected during various projects that took place at the City-owned portion of AZ U:9:1(ASM), also known as Pueblo Grande, between 1935 and 1985. Pueblo Grande, listed on the National Register of Historic Places and Phoenix's only National Historic Landmark, was occupied from roughly AD 450 through AD 1450 and contains one of the last two remaining intact platform mounds along the lower Salt River Valley – the other being located at Mesa Grande (AZ U:9:25 [ASM]) on the south side of the river.

For purposes of this paper, we refer to this pottery assemblage as the PG Park collection. Early excavations at AZ U:9:1(ASM)/Pueblo Grande were not well documented, and their results remained unpublished until

the Pueblo Grande Archival Project was completed, a study of unpublished archaeological investigations at Pueblo Grande (Downum and Bostwick 1993). Several people have contributed to the identification of the PG Park pottery assemblage. Most of the sherds discussed in this paper were analyzed in 1993 by Alfred E. Dittert, Jr. and Todd W. Bostwick. Some were analyzed by Harold Colton in 1939 and 1940. In addition, Doyel (1987, 1989, 1993) examined nonlocal ceramics collected during the 1930s excavations at Pueblo Grande, a subset of this collection. Subsequent to these studies, Holly Young, former Pueblo Grande Museum Curator, examined the sherds during the course of the curation process, assigned types to some of the sherds that were listed as “unidentified,” and in a few cases reassigned sherds to different types. Tucson Basin and San Carlos wares from this collection were subjected to a more detailed temper analysis in 2014 by Andrew Lack. Patrick Lyons, Kelley Hays-Gilpin, and Chris Downum examined selected northern wares in 2017. Other sherds subsequently found in the PG Park collections that had not been previously analyzed were examined in 2018 by Jim Graceffa of the Verde Valley Archaeology Center.

We have used the term “nonlocal” rather than “intrusive” for our study since the latter is ambiguous and, in our opinion, nonlocal better describes the pottery as not being manufactured in the Phoenix Basin. Salado Polychromes are not part of this study, because it is unclear where they were made, and some may have been manufactured locally. Hohokam ceramics from the Tucson Basin are included because Lack's (2014) detailed study determined that they were not locally made.

The study of nonlocal ceramics has the potential to inform us about change in cultural interactions over time. For instance, previous studies have shown that the Hohokam imported many trade wares from northern Arizona during the Pre-classic period, and more from

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southern Arizona during the later Classic period (Crown 1984:Table II.7.6; Beckwith 1988:239; Foster 1994:146). The comparison of pottery assemblages from different sites allows us to make inferences about which groups were interacting with different Hohokam villages. We can also potentially learn if different Hohokam households had more access to trade wares and other specialized or nonlocal commodities compared to others. However, our study is somewhat limited by the absence of specific provenience data at Pueblo Grande, because, as stated earlier, these sherds come from excavations that were not always well documented. Without detailed provenience information, we chose to focus on broad patterns between the platform mound complex and non-mound areas at Pueblo Grande. More specifically, the platform mound complex consists of the platform mound itself and rooms in the Northwest compound – both of which were enclosed by a massive compound wall that was up to 1 m thick and 3 m tall. Non-mound areas consist of houses, pits, the ballcourt, and trash mounds located away from the platform mound.

As part of our study, we compare the PG Park nonlocal pottery assemblage with the nonlocal ceramics recovered from the State Route 143 (SR 143) project, located within the portion of Pueblo Grande to the east and northeast of the PG Park (Figure 1). The excavations undertaken for the SR 143 project, also known as the Hohokam Expressway, took place between January 1989 and April 1990 and were conducted in order to mitigate the impacts from construction of State Route 143 (SR 143) under provisions of Section 106 of the National Historic Preservation Act. More than 16 ac of horizontal area was stripped, resulting in the excavation of almost 350 architectural features, 1,800 pit features, and 836 human burials (Breternitz 1994:ix). These features dated from the late Sedentary through late Classic periods (Foster 1994).

We also compare the PG Park nonlocal pottery with nonlocal ceramic assemblages from two other platform mound sites, La Ciudad and Las Colinas, both of which are located on the same canal system as Pueblo Grande – Canal System 2. These sites have well documented nonlocal pottery assemblages, and their location in the middle of Canal System 2 (La Ciudad) and at its terminus (Las Colinas) provide an opportunity to examine potential differences in exchange networks for each of the three sites.

## METHODS

We grouped the pottery types in the PG Park collection according to “wares,” which reflect pottery-making traditions of different regions and cultures. This classification system allowed us to make comparisons with nonlocal ceramics collected from the SR 143 project. There are limitations to using a ware classification. Some types do not easily fit into wares, which resulted

in using ware categories such as “Northern Mexico/Chihuahuahua” and “Central Arizona Ceramic Tradition.”

Most of the PG Park pottery collection, except for the Tucson Basin and San Carlos sherds, was analyzed only macroscopically. Sherds were assigned type designations based on attributes such as color, paint type, and design style. Once types were assigned, designations were confirmed by analyzing paste and temper type with a 10× hand lens.

Attempts were made to determine the vessel form (bowl versus jar; bowl form) represented by the individual sherds. Vessel form was assessed by looking at rim form, finishing treatments, and the presence and location of decoration. In addition, an effort was made to determine the number of whole vessels represented in the assemblage. Where portions of vessels could be re-constructed by refitting sherds, this could be done with a degree of confidence. However, where this was not possible, assigning multiple sherds to single vessels was based on design patterns or other similarities in decoration, color, morphology, and paste characteristics.

Provenience and context were also considered when making the pottery type assignments. When it was possible to determine that multiple sherds originated from the same vessel, they were counted as a single occurrence. With the exception of Tucson Basin and San Carlos Wares analyzed by Lack (2014), an examination of rims for the purpose of estimating vessel orifice diameter was not completed as part of this study. Most of the sherds in this collection are very small in size and of limited value for making orifice diameter projections.

## CHARACTERISTICS OF THE PG PARK NONLOCAL POTTERY COLLECTIONS

### PG Park Nonlocal Pottery Assemblage

There are 451 sherds in this collection, which amounts to only 0.059 per cent of the total of more than 767,824 ceramics collected from PG Park during this time. The only whole vessels in the PG Park collection consist of a Kana-a Black-on-white jar, a Black Mesa Black-on-white jar, a Tumco Buff jar, and a Bluff Black-on-red jar.

The nonlocal pottery in the PG Park collection represents at least 18 different wares – with 61 different types. Some indeterminate types could be grouped into ware categories whereas others could not be typed beyond recognizing that they are not local. Tusayan White Ware (n=96, 21.3 %) is the most frequent nonlocal ware. The second most common pottery ware is Tucson Basin/San Carlos Wares (n=70, 15.5%), followed by Little Colorado White Ware (n=39, 8.7%), and Cibola White Ware (n=36, 8.0%).

Two of the most frequent pottery sherd types in the PG Park nonlocal collection are from two entirely different regions, Tanque Verde Red-on-brown (n=58) from

the Tucson Basin region in southern Arizona and Deadman's Black-on-red ( $n=35$ ) from southeastern Utah and northeastern Arizona. Six sherds in the PG Park assemblage came a long way from the Northwest Mexico/Chihuahuah region (Ramos Black, Ramos Polychrome, and Chihuahuah Plain Smudged).

A Maverick Mountain polychrome sherd from a jar was found with the cremation burial of a female adult located west of the platform mound. This burial, which dates to the Sacaton phase, was placed on a bench inside a pit. An inverted bowl sherd and other sherds were heaped over the burial on the bench. Maverick Mountain polychrome is a derivative of Tsegi Orange Ware and Tusayan White Ware, two pottery traditions of northeastern Arizona and Southeastern Utah (Lyons 2012). Maverick Mountain polychrome has been attributed to immigrants from the Kayenta region producing their Kayenta orange ware tradition pottery with clay and tempers from the southern Southwest.

Most of the PG Park nonlocal sherds are from bowls, representing 220 bowls versus 128 jars, with the remainder not identified as to vessel form. This is a ratio of 1.72 bowls to 1 jar. A higher percentage of bowls versus jars is typical for nonlocal ceramics assemblages from Hohokam sites, especially during Pre-classic periods (Beckwith 1988; Crown 1984).

The nonlocal pottery types from PG Park date from the Hohokam Colonial period through the Classic period, with most sherd types from the Sedentary period. In her pioneering study of Hohokam ceramic exchange, Patricia Crown (1984:262) found that nonlocal ceramics from most Hohokam areas occurred in greatest abundance during the Sedentary period. However, at least 15 different nonlocal pottery types were found at PG Park that date to the Hohokam Classic period, indicating that interaction with northern and southern groups still occurred during this time period (Table 1). The wide variety of nonlocal ceramic types at PG Park were acquired from

several different cultural groups or regions including the Kayenta, Little Colorado, and Cibola branches of the Ancestral Pueblo, Mogollon, Cohonina, Prescott, Tucson Basin, and others (Figure 2).

### SR 143 Project Nonlocal Pottery Assemblage

Nonlocal pottery types recovered from the SR 143 project consist of 265 sherds and four complete or nearly complete vessels, not including Salado Polychrome (Foster 1994:119). Most of these date from the Sedentary period through the Classic period. Four Pima Plain sherds and one Pima Red-on-buff bowl found in the SR 143 project area were not included in our study since the focus of our study did not include the proto-historic or historic period. The other two whole vessels are Black Mesa Black-on-white and Kia-ko Black-on-white, both of which are Tusayan White Ware jars used in mortuary contexts at the site (Foster 1994:129). The Black Mesa Black-on-white jar was from an inhumation in Burial Group 6, located about 250 m northeast of the platform mound, and the Kia-Ko Black-on-white jar came from a cremation in Burial Group 11, approximately 100 m to the east of the platform mound.

Excluding the nonlocal ceramic types listed above, 15 different wares and 53 nonlocal types were identified in the SR 143 nonlocal ceramic assemblage (Table 2; Foster 1994:Table 4.2). Little Colorado White Ware and Tu-

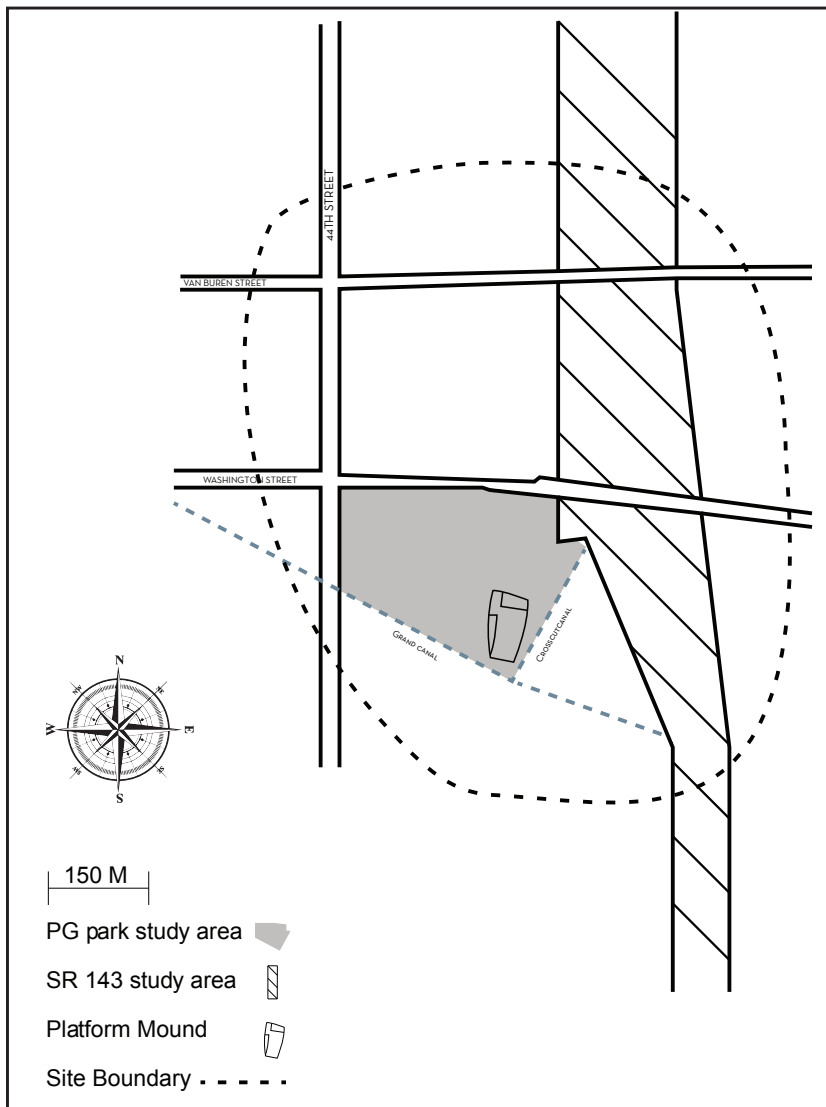


Figure 1. Location of PG Park study area and SR 143 study area.

Table 1. Sherd counts for nonlocal ceramics from the PG Park project.\*

<b>Alameda Brown Ware</b>		<b>Mogollon Brown Ware</b>		<b>Tusayan White Ware</b>	
Sunset Brown A	1	Woodruff Brown	3	Kana-a Black-on-white	33 (1)
Winona Corrugated	15	Maverick Mountain Poly-chrome	0 (1)	Sosi Black-on-white	11
<b>Subtotal / Percentage</b>	<b>16 / 3.6%</b>	Reserve Plain Smudged	2	Black Mesa Black-on-white	33 (1)
<b>Central Arizona Ceramic Tradition</b>		Tularosa White-on-red	1	Flagstaff Black-on-white	2
Vosberg Red	1	Dragoon Red-on-brown	2	Kia-ko Black-on-white	1
Gila White-on-red	10	Linden Corrugated	5	Polacca Black-on-white	1
Gila Black-on-red	1	Three Circle Neck Corrugated	1	Dogoszhi Black-on-white	1
Salado Red	5	<b>Subtotal / Percentage</b>	<b>15 / 3.3%</b>	Indeterminate	14
Tonto Corrugated	1	<b>Northwest Mexico/ Chihuahua Wares</b>		<b>Subtotal / Percentage</b>	<b>96 / 21.3%</b>
Tonto Brown	3	Ramos Black	2	<b>Tucson Basin Brown/ San Carlos Ware/ Hohokam nonlocal</b>	
<b>Subtotal / Percentage</b>	<b>21 / 4.7%</b>	Ramos Polychrome	3	Tanque Verde Red-on-brown	58
<b>Cibola White Ware</b>		Chihuahua Plain Smudged	1	San Carlos Red-on-brown	4
Escavada Black-on-white	1	<b>Subtotal / Percentage</b>	<b>6 / 1.3%</b>	Tucson Black-on-red	1
Gallup Black-on-white	1	<b>Prescott Gray Ware</b>		Indeterminate Red-on-brown	7
Snowflake Black-on-white	25	Prescott Black-on-gray	3	<b>Subtotal / Percentage</b>	<b>70 / 15.5%</b>
Reserve Black-on-white	2	Prescott Gray	2	<b>White Mountain Red Ware</b>	
Mangus Black-on-white	1	<b>Subtotal / Percentage</b>	<b>5 / 1.1%</b>	Pinedale Black-on-red	7
Puerco Black-on-white, Escavado variety	1	<b>San Francisco Mountain Gray Ware</b>		Fourmile Polychrome	3
Red Mesa Black-on-white	1	Deadman’s Black-on-gray	4	Pinedale Polychrome	2
Indeterminate Black-on-white	4	Floyd Black-on-gray	5	Indeterminate Black-on-red	1
<b>Subtotal / Percentage</b>	<b>36 / 8%</b>	<b>Subtotal / Percentage</b>	<b>9 / 2%</b>	<b>Subtotal / Percentage</b>	<b>13 / 2.9%</b>
<b>Jeddito Yellow Ware/Hopi Wares</b>		<b>San Juan Red Ware</b>		<b>Winslow Orange Ware</b>	
Awatovi Black-on-yellow	2	Deadman’s Black-on-red	35	Chavez Black-on-red	1
Jeddito/Awatovi Black-on-yellow	13	<b>Subtotal / Percentage</b>	<b>35 / 7.8%</b>	<b>Subtotal / Percentage</b>	<b>1 / 0.2%</b>
Jeddito Black-on-yellow	13	<b>Tsegi Orange Ware</b>		<b>Zuni-Acoma Glaze Ware</b>	
Bidahochi Polychrome	5	Medicine Black-on-red	6	Heshotautla Polychrome	2
<b>Subtotal / Percentage</b>	<b>33 / 7.3%</b>	Tusayan Black-on-red	11	<b>Subtotal / Percentage</b>	<b>2 / 0.4%</b>
<b>Little Colorado White Ware</b>		Kayenta Polychrome	1	<b>Indeterminate</b>	
Holbrook Black-on-white	33	Indeterminate	3	Indeterminate	3
Holbrook Black-on-white, A	1	<b>Subtotal / Percentage</b>	<b>21 / 4.7%</b>	Indeterminate, corrugated	20
Padre Black-on-white	1	<b>Tusayan Gray Ware</b>		<b>Subtotal / Percentage</b>	<b>23 / 5.1%</b>
Walnut Black-on-white	4	Tusayan Corrugated	4	Note: * - In cases where there are two numbers, the first number is the sherd count and the second number refers to whole vessels, which are not counted in the sherd counts.	
<b>Subtotal / Percentage</b>	<b>39 / 8.7%</b>	Moenkopi Corrugated	1		
<b>Lower Colorado Buff Ware</b>		<b>Subtotal / Percentage</b>	<b>5 / 1.1%</b>		
Tumco Buff	1 (1)				
Topoc Buff	1				
Bluff Black-on-red	0 (1)				
Indeterminate Buff Ware	3				
<b>Subtotal / Percentage</b>	<b>5 / 1.1%</b>				



Table 2. Sherd counts for nonlocal ceramics from the SR 143 project.\*

<b>Alameda Brown Ware</b>		<b>Mogollon Brown Ware</b>		<b>Tucson Basin Brown/ San Carlos Ware/ Hohokam nonlocal</b>	
Sunset Red A	1	Linden Corrugated	10	Tanque Verde Red-on-brown	16
Sunset Brown A	1	Heber Corrugated	3	Rincon Red-on-brown	4
Chavez Brown, Kinnikinick variety	1	Silver Creek Corrugated	3	San Carlos Red	1
<b>Subtotal / Percentage</b>	<b>3 / 1.0%</b>	McDonald Corrugated	5	San Carlos Red-on-brown	13
<b>Central Arizona Ceramic Tradition</b>		Tularosa Corrugated	1	Wingfield Plain, Queen Creek	1
Vosberg Red	2	El Paso Polychrome	1	Wingfield Red	1
Vosberg Plain	1	<b>Subtotal / Percentage</b>	<b>23 / 9.0%</b>	Tonto Corrugated	1
Gila Black-on-red	6	<b>Northwest Mexico/ Chihuahua Wares</b>		Indeterminate	1
Salado Red	6	Carritos Polychrome	2	Indeterminate Red-on-brown	3
<b>Subtotal / Percentage</b>	<b>15 / 6.0%</b>	<b>Subtotal / Percentage</b>	<b>2 / 1.0%</b>	Casa Grande/Sacaton Red-on-buff, Nonlocal	2
<b>Cibola White Ware</b>		<b>Prescott Gray Ware</b>		Sacaton Red-on-buff, Nonlocal	1
Snowflake Black-on-white	12	Prescott Black-on-plain	8	Classic Period Red Ware	0 (1)
Roosevelt Black-on-white	1	Prescott Plain	1	<b>Subtotal / Percentage</b>	<b>44 / 17.0%</b>
<b>Subtotal / Percentage</b>	<b>13 / 5.0%</b>	<b>Subtotal / Percentage</b>	<b>9 / 3.0%</b>	<b>White Mountain Red Ware</b>	
<b>Jeddito Yellow Ware/Hopi Wares</b>		<b>Tsegi Orange Ware</b>		Pinedale Black-on-red	3
Jeddito Black-on-yellow	4	Medicine Black-on-red	1	Indeterminate Black-on-red	2
Hoyapi Black-on-white	1	Tusayan Black-on-red	14	<b>Subtotal / Percentage</b>	<b>5 / 2.0%</b>
<b>Subtotal / Percentage</b>	<b>5 / 2.0%</b>	Tsegi Polychrome	1	<b>Indeterminate</b>	
<b>Little Colorado Gray Ware</b>		Indeterminate	1	Indeterminate, possibly Mexican	1
Little Colorado Corrugated	3	<b>Subtotal / Percentage</b>	<b>17 / 6.0%</b>	Indeterminate, red ware	1
<b>Subtotal / Percentage</b>	<b>3 / 1.0%</b>	<b>Tusayan Gray Ware</b>		Indeterminate, gray ware	1
<b>Little Colorado White Ware</b>		Tusayan Corrugated	4	Indeterminate, Flagstaff	17
Holbrook Black-on-white A	2	Moenkopi Corrugated	1	Indeterminate, red-on-brown	1
Holbrook Black-on-white B	6	<b>Subtotal / Percentage</b>	<b>5 / 2.0 %</b>	Indeterminate	1
Holbrook Black-on-white	11	<b>Tusayan White Ware</b>		<b>Subtotal / Percentage</b>	<b>22 / 8.0%</b>
Walnut Black-on-white	33	Kana-a Black-on-white	4	Note: * - In cases where there are two numbers, the first number is the sherd count and the second number refers to whole vessels, which are not counted in the sherd counts.	
Padre Black-on-white	1	Polacca Black-on-white	1		
Indeterminate	1	Sosi Black-on-white	8		
<b>Subtotal / Percentage</b>	<b>54 / 20.0%</b>	Black Mesa Black-on-white	10 (1)		
<b>Lower Colorado Buff Ware</b>		Flagstaff Black-on-white	2		
Tumco Buff	5	Kia-ko Black-on-white	2 (1)		
Topoc Buff	2	Indeterminate	3		
Parker Buff	1	<b>Subtotal / Percentage</b>	<b>30 / 11.0%</b>		
Parker Red-on-buff	1				
Black Mesa Red-on-buff	1				
Indeterminate	5				
<b>Subtotal / Percentage</b>	<b>15 / 6.0%</b>				

sayan White Ware dominated the assemblage and most nonlocal sherds came from northern Arizona; the single most frequent nonlocal type was Walnut Black-on-white. However, Cibola White Ware, Mogollon Brown Ware; Lower Colorado Buffware; and Tucson Basin types are well represented. Two sherds from the Northwest Mexico/Chihuahua regions (Carretas Polychrome) were identified in the nonlocal assemblage. Most of the nonlocal vessels in the SR 143 assemblage are bowls, with approximately 3.3 nonlocal bowls to every nonlocal jar (Foster 1994:141).

### COMPARISONS OF PG PARK AND SR 143 PROJECT NONLOCAL POTTERY

Frequencies of nonlocal pottery that were recovered from the PG Park and from the SR 143 project collections are compared in Figure 3. Quantities and frequencies of the nonlocal pottery are listed in Table 3. Pottery dates for selected types are provided in Table 4.

Tusayan White Ware, Little Colorado White Ware, and Tucson Basin/San Carlos Wares are common in each of the ceramic collections from the PG Park and SR 143 Project, although the frequency of Tusayan White Wares and Tucson Basin/San Carlos Wares is much higher in the PG Park study. The total number of nonlocal sherds is about twice as high in PG Park, with only 265 found in the SR 143 project and 451 found in our study. Although the SR 143 Project was more extensively excavated compared to the PG Park, the platform mound complex is in the PG Park and 99 nonlocal sherds were recovered from this special architectural feature. It is unclear how the overall sherd assemblages for each project area compare, but a total of 767,824 sherds were found in the PG Park and “over 500,000 sherds” were washed for the SR 143 Project (Breternitz 1994:ix). In addition, for some of the nonlocal sherd types, although a higher frequency was found in the PG Park collection, the percentage of the same types was roughly equivalent. For example, the number of Tucson Basin/San Carlos Red-on-brown sherds was higher in the PG Park ( $n=70$ ) compared to the SR 143 Project ( $n=44$ ), yet their percentages (15.5% vs 17.0%) are close.



Figure 2. Geographic locations for pottery wares identified in the PG Park study.

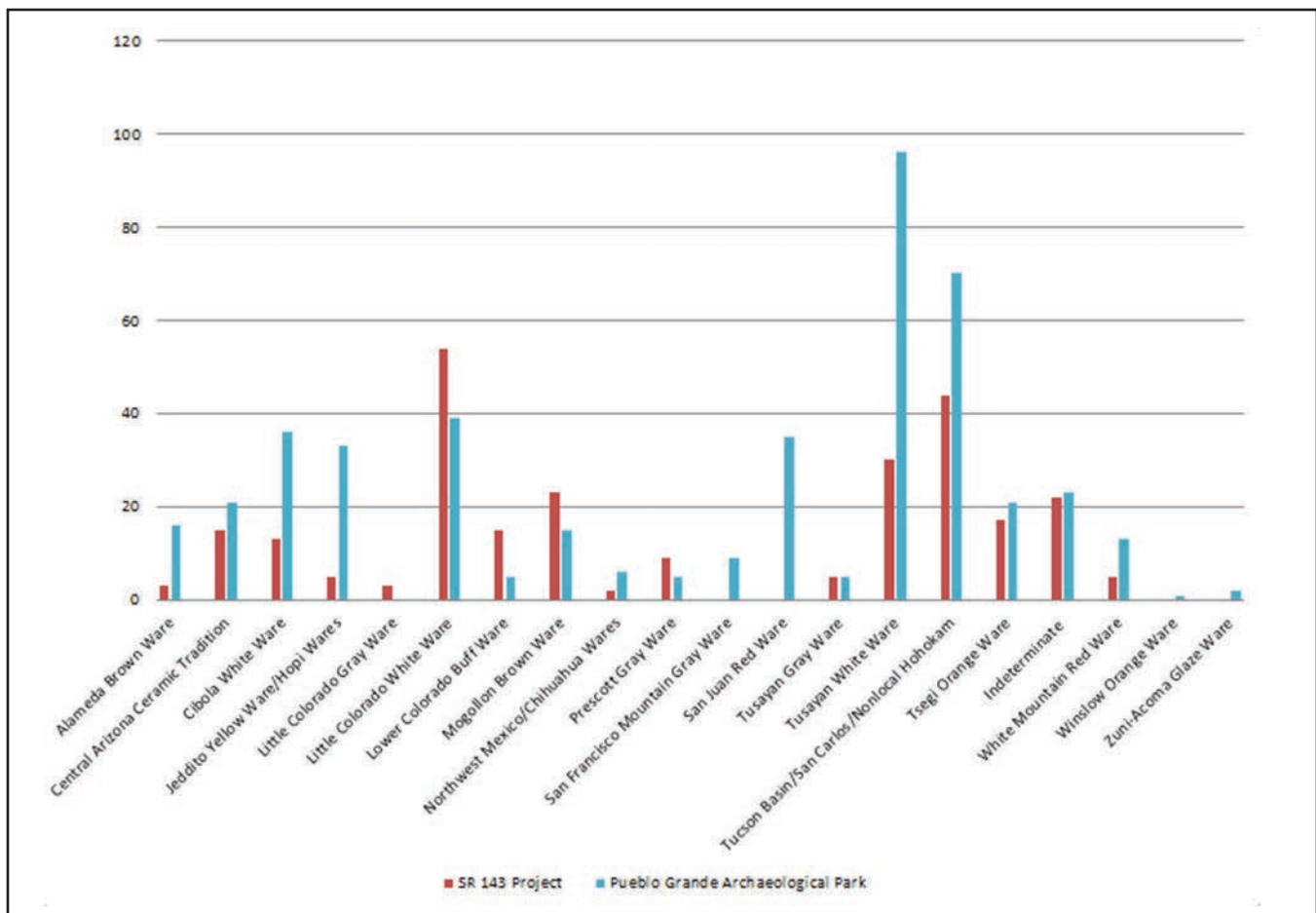


Figure 3. Frequency comparisons of nonlocal sherds from PG Park and SR 143.

Although there are some similarities in the two nonlocal assemblages, Alameda Brown Ware, Cibola White Ware, Jeddito Yellow Ware, Tusayan White Ware, and San Juan Red Ware are all more frequent in the PG Park collection compared to the SR 143 project. This included both early types, such as Deadman's Black-on-red (San Juan Red Wares), which dates from AD 825-1065 (Sorrell et al. 2018: 131), and some later types such as Jeddito Black-on-Yellow, dating from AD 1300-1600 (Adams 2014; Colton 1956; Colton and Hargrave 1937; Dittert and Plog 1980). In addition, San Francisco Mountain Gray Ware, San Juan Red Ware, and Zuni-Acoma Glaze Ware are present only in the PG Park. In contrast, Little Colorado White Ware, Lower Colorado Buff Ware, Mogollon corrugated types, and Prescott Gray Wares are more frequent in the SR 143 Project assemblage.

Figure 4 shows the locations for non-local ceramics in the PG Park study for which we had sufficient provenience information with which to plot them. Their contexts are as follows: 99 nonlocal sherds are from the platform mound, 26 are from pithouses, 49 are from the trash mounds, 5 are from cremations (1 is a bighorn sheep cache discussed below), 3 are from fill within the ballcourt, and only 2 are from pits. Others were found in trenches or other excavations where feature or spe-

cific contextual information either did not exist or had not been recorded. These pithouses and trash mounds dated from the Colonial period through the Classic period (ca. AD 700-1400), and the fill within the ballcourt dated to the Sedentary and Classic period (Bostwick and Downum 1994).

There is no consensus on the function of Hohokam platform mounds (Elson 1998). They have been variously interpreted as having served as elite or leadership residences (Doyel 1981; Elson 1998; Gregory 1987; Rice 1997; Rice et al. 1998; Wilcox 1987, 1988, 1991) that also functioned for food storage and redistribution (Crown and Fish 1996; Jacobs and Rice 1997; Lindauer 1995; Wilcox 1988, 1991) and as places where religious activities and celestial observations were conducted (Bostwick 1992; Craig et al. 1998; Bostwick and Downum 1994; Howard 1992; Jacobs 1992; Mixon 1989; Shapiro 1999). O'Dodham oral history discusses "Great Houses" where village leaders lived (Bahr et al. 1994).

Whittlesey and Ciolek-Torrello (1992) suggest that during the Classic period clans and sodalities managed labor, allocated land, resolved conflicts, and integrated settlement within a community-wide ceremonial framework. Elson (1998:14) argues that "the mounds probably served in some way, either through ceremonial



or administrative means or perhaps a combination of the two, to integrate segments of the population and regulate irrigation and other subsistence activities.” Abbott et al. (2006:300) suggest a social hierarchy may have emerged during the Classic period in order to manage individual irrigation systems, such as Canal System 2, into a focal organized political community that included non-irrigation land surrounding the platform mound village.

Excavation of a portion of the Pueblo Grande platform mound in the 1930s documented specialized artifacts and unusual architecture, supporting a religious and administrative function for the mound, but it may not have served as a full-time residence for an elite group of individuals (Downum and Bostwick 2003:167). However, those individuals associated with the platform mound likely had significant influence over the Pueblo Grande village and other villages located in Canal System Two. Whatever the function(s) were of Hohokam platform mounds, we assume that ceramics and other objects found near the Pueblo Grande platform mound

probably had greater value or cultural meaning, and that they may represent more formal connections with other groups compared to ceramics found away from the platform mound.

Systematic excavations for the SR 143 Project area uncovered 14 discrete habitation areas, each consisting of a cluster of structures, pits, and trash middens. In addition, 17 cemeteries were present, containing 647 inhumations and 189 cremated individuals (Abbott and Foster 2003:25). Population estimates for this area ranged from 593 persons in the early Classic to 466 during the late Classic (Abbott and Foster 2003:Table 2.2).

There is an interesting pattern in the distribution of nonlocal pottery from the SR 143 project portion of AZ U:9:1(ASM)/Pueblo Grande. Most of the nonlocal sherds were from two adjacent habitation areas – Habitation Areas 7 and 2, which contained 44% of the total of nonlocal ceramics from that collection (n=119) (Foster 1994:154). These habitation areas also had a greater quantity and diversity of other specialized imported items such as turquoise, shell, and obsidian, than did other habitation areas. These two habitation areas are not located near the platform mound but are approximately 300 m to the northeast. The presence

**Table 3. Percentages of nonlocal pottery in the PG Park and SR 143 collections.**

Pottery Ware	SR 143		PG Park	
	Count	Percent	Count	Percent
Alameda Brown Ware	3	1.3	16	3.6
Central Arizona Ceramic Tradition	15	6	21	4.7
Cibola White Ware	13	5	36	8
Jeddito Yellow Ware	5	2	33	7.3
Little Colorado Gray Ware	3	1	0	0
Little Colorado White Ware	54	20	39	8.7
Lower Colorado Buff Ware	15	6	5	1.1
Mogollon Brown Ware	23	9	15	3.3
Northwest Mexico/Chihuahua Wares	2	1	6	1.3
Prescott Gray Ware	9	3	5	1.1
San Francisco Mountain Gray Ware	0	0	9	2
San Juan Red Ware	0	0	35	7.8
Tusayan Gray Ware	5	2	5	1.1
Tusayan White Ware	30	11	96	21.3
Tucson Basin/San Carlos Wares	44	17	70	15.5
Tsegi Orange Ware	17	6	21	4.7
Indeterminate	22	8	23	5.1
White Mountain Red Ware	5	2	13	2.9
Winslow Orange Ware	-	-	1	0.2
Zuni-Acoma Glaze Ware	-	-	2	0.4
<b>Totals</b>	<b>265</b>	<b>100</b>	<b>451</b>	<b>100</b>

of more non-local ceramics in these two habitation areas may have been the result of outsiders moving into Pueblo Grande, or perhaps the two habitation areas had stronger ties with distant villages. Abbott and Foster (2003:43-44) argue that an influx of migrants from outside the Salt River Valley appear to have established several residential areas at the outskirts of the Pueblo Grande village. These new residents not only increased the population of the village significantly, but they also may have contributed to the existing exchange network at Pueblo Grande.

## SELECTED WARE DISCUSSION

### Tusayan White Ware

Tusayan White Ware, associated with the Kayenta Tradition of the Ancestral Pueblo culture of northeastern Arizona (Colton and Hargrave 1937), is the most common ware in our study with a total of 96 sherds (21.3%) and two whole vessels. Tusayan White Ware was manufactured during a span of time that corresponds to the Hohokam Colonial through early Classic periods. Most Tusayan White Wares in our collection are Kana-a Black-on-white and Black Mesa Black-on-white – they occur in equal amounts. Each of these types represents differ-

**Table 4. Dates and references for selected pottery types discussed in this study.**

Ware, Type	Dates (AD)	References (listed in same order as dates)
<b>Alameda Brown Ware</b>		
Sunset Brown A	1075-1300	Wilcox 2015
Winona Corrugated	1050-1100	Breternitz 1966:104
<b>Central Arizona Ceramic Tradition</b>		
Gila White-on-red	1200-1400	Wood 1987
Tonto Brown	1000-1400	Wood 1987
<b>Cibola White Ware</b>		
Escavada Black-on-white	1000-1130	Wilcox 2015
Snowflake Black-on-white	1100-1250, 1100-1275	Hays-Gilpin & van Hartesveldt 1998; Wilcox 2015
Reserve Black-on-white	1000-100, 1030-1200	Bernardini 2005:Table 3.1; Peckham 1990
Puerco Black-on-white, Escavado variety	1030-1150	Wilcox 2015
Red Mesa Black-on-white	950-1050	Wilcox 2015
<b>Jeddito Yellow Ware</b>		
Awatovi Black-on-yellow	1300-1350	Hays-Gilpin & van Hartesveldt 1998
Jeddito Black-on-yellow	1350-1600	Hays-Gilpin & van Hartesveldt 1998
<b>Little Colorado White Ware</b>		
Holbrook Black-on-white	1050-1200	Hays-Gilpin & van Hartesveldt 1998; Sorrell et al. 2018: Table 3;
Holbrook Black-on-white, Type A	1025-1150	Douglass 1987; Sorrell et al. 2018
Padre Black-on-white	1050-1200, 1100-1250	Douglass 1987; Hays-Gilpin & van Hartesveldt 1998; Sorrell et al. 2018:Table 3
Walnut Black-on-white	1150-1225	Sorrell et al. 2018:Table 3
<b>Lower Colorado Buff Ware</b>		
Tumco Buff	1000-1500	Waters 1982
Topoc Buff	1000-1500	Waters 1982
<b>Mogollon Brown Ware</b>		
Maverick Mountain Polychrome	1265-1290	Oppelt 2007:21
Three Circle-Neck Corrugated	800-1000	Haury 1936; Wilson 1999
<b>Northwest Mexico/Chihuahua Ware</b>		
Ramos Black	1200-1660	Whalen and Minnis 2001: Figure 2.1
<b>Prescott Gray Ware</b>		
Prescott Black-on-gray	1050-1300	Keller 1993:67
Prescott Gray	1025-1200	Keller 1993:67
<b>San Francisco Mountain Gray Ware</b>		
Deadman's Black-on-gray	1025-1175	Downum 1994
Floyd Black-on-gray	800-1025	Sorrell 2005
<b>San Juan Red Ware</b>		
Deadman's Black-on-red	825-1065	Sorrell et al. 2018:Table 3
Bluff Black-on-Red	750-900	Christenson 1994
<b>Tusayan Gray Ware</b>		
Tusayan Corrugated	1050-1175	Sorrell et al. 2018:Table 3
Lino Black-on-gray	550-825	Sorrell et al. 2018:Table 3

**Table 4. Dates and references for selected pottery types discussed in this study (continued).**

Ware, Type	Dates (AD)	References (listed in same order as dates)
<b>Tusayan White Ware</b>		
Kana-a Black-on-white	800-1025, 725-1000	Hays-Gilpin and van Hartesveldt 1998; Sorrell et al. 2018:Table 3
Sosi Black-on-white	1050-1200, 1070-1180	Hays-Gilpin and van Hartesveldt 1998; Sorrell et al. 2018:Table 3
Black Mesa Black-on-white	1025-1150, 1000-110, 900-1160	Christenson 1994; Goetz and Mills 1993; Sorrell et al. 2018:Table 3
Flagstaff Black-on-white	1150-1225, 1150-1220	Goetz and Mills 1993; Sorrell et al. 2018:Table 3
Dogoszhi Black-on-white	1050-1200	Sorrell et al. 2018:Table 3
<b>Tucson Basin/San Carlos Wares</b>		
Tanque Verde Red-on-brown	700-1300	Heckman 2000:83
San Carlos Red-on-brown	1150-1400	Wood 1987
Tucson Black-on-red	1275-1450	<a href="https://www.archaeologysouthwest.org/pdf/ceramic-type-ware.pdf">https://www.archaeologysouthwest.org/pdf/ceramic-type-ware.pdf</a>
<b>Tsegi Orange Ware</b>		
Medicine Black-on-red	1050-1125	Downum 1994
Tusayan Black-on-red	1065-1200, 1000-1300	Downum 1994; Hays-Gilpin and van Hartesveldt 1998
Kayenta Polychrome	1215-1300	Wilcox 2015
<b>White Mountain Red Ware</b>		
Pinedale Black-on-red	1275-1325	Wilcox 2015
Fourmile Polychrome	1325-1425	Wilcox 2015
Pinedale Polychrome	1275-1350	Wilcox 2015

ent spans of time – Kana-a dates from AD 725 to 1000 (Hays-Gilpin and van Hartesveldt 1998:111) and AD 800 to 1000 (Goff and Reed 1998). Sorrell et al. (2018) date Black Mesa Black-on-white from AD 1025-1150, Sosi and Dogoszhi Black-on-white from AD 1050-1200, and Flagstaff Black-on-white from AD 1150-1250.

Tusayan White Wares were found in concentrations that correspond to some of the trash mounds and other non-platform mound/compound areas, including two of the whole vessels recovered from PG Park, a Kana-a Black-on-white jar and a Black Mesa Black-on-white jar. This is not surprising since their manufacture and occurrence in trade contexts generally pre-dates platform mound architecture (Beckwith 1988:232; Doyel 1991). Tusayan White Ware was also the most common ware from the SR 143 project, although there were much fewer sherds found in that part of Pueblo Grande.

The Kana-a Black-on-white jar is an early ceramic type from northern Arizona (Figure 5, left). It was part of an unusual Colonial period cache containing cremated bighorn sheep horns and other possibly ceremonial artifacts (HC128). This cache was found in the plaza area west of the platform mound and beneath Trash Mound 3 (Bostwick and Downum 1994:Table 8.2, Figures 8.5 to 8.7). In addition to specialized ground stone objects, there were eight projectile points, five stone effigy vessels, and eight waterworn stones. Other ceramics in-

clude a Santa Cruz Red-on-buff jar, a Red-on-buff censer, and nearly 3,000 sherds (some with specular iron). The Santa Cruz pottery suggests the feature dates to the Colonial period, which is consistent with the dating of the Kana-a Black-on-white jar.

A Black Mesa Black-on-white jar was found in a Sacaton-Soho phase cremation burial (HC29) located about 3 m west of the platform mound (Figure 5, right). The jar was located in the lower portion of a double pit, and served as the cremation urn, which was capped by a plainware bowl and by other nested bowl sherds (Brunson-Hadley 1994). Age and sex of the cremated individual is unknown.

### **Tucson Basin/San Carlos Wares**

This group of sherds was typed according to established ceramic sequences from the Tucson Basin (Deaver 1984; Greenleaf 1975; Heckman 2000; Kelly et al.1978; Wallace 1986a, 1986b), and southeastern Arizona, in general (Heckman 2000; Neuzil and Lyons 2005). They have a dense, brown paste; sand or schist temper, or both; red slips or thin white slips or washes; and red, black, or white paint. They have a decorative treatment that “follows the stylistic punctuations in Hohokam Buff Ware,” with their center of manufacture primarily in the Santa Cruz Valley of southern Arizona (Heckman 2000:83).



Seventy sherds were classified as Tucson Basin/San Carlos Wares with most being Tanque Verde Red-on-brown ( $n=58$ ). Tanque Verde Red-on-brown dates to the Classic period, AD 1150-1300 (Whittlesey 1988:382). Analysis by Andrew Lack (2014) determined that production sources for these nonlocal ceramics were variable – the Tortolita and Tucson Mountains and likely their associated washes. Ownby and Miska (2012:32) have argued that “potters at several sites in the northern Tucson Basin were producing and distributing Tanque Verde Red-on-brown.” Pueblo Grande did not appear to have any type of exclusive relationship with a particular production source for this type of ceramic. Therefore, it appears that Pueblo Grande inhabitants maintained economic networks with various groups in the Tucson Basin.

Tanque Verde Red-on-brown sherds were more commonly found on the Pueblo Grande platform mound or close to it, suggesting these ceramics were associated with platform mound activities. Lack (2014) found that most Tanque Verde Red-on-brown sherds represent jars

(67%) – in contrast to other nonlocal ceramics which favor bowls. The Tanque Verde Red-on-brown jars are generally small with narrow necks and they could have been used to transport liquids such as water or saguaro wine or syrup, or were used as seed jars.

Tucson Basin Brown Ware sherds were also common in the SR 143 collection, where there were 44 (17.0%). This included three Tanque Verde Red-on-brown sherds that were subjected to neutron activation analysis, which confirmed they were nonlocal and came from multiple sources (Fish et al. 1992; Harry 1997:Table 6.1). There were also 13 San Carlos Red-on-brown sherds. This ceramic type has been described as a type without a ware, and there are differences of opinion as to whether it is part of the Hohokam or the Mogollon tradition, with some researchers viewing it as hybrid of both (Neuzil and Lyons 2005; Wood 1987).

### Little Colorado White Ware

There are 39 Little Colorado White Ware sherds in the PG Park collection (8.7%). This pottery ware is as-

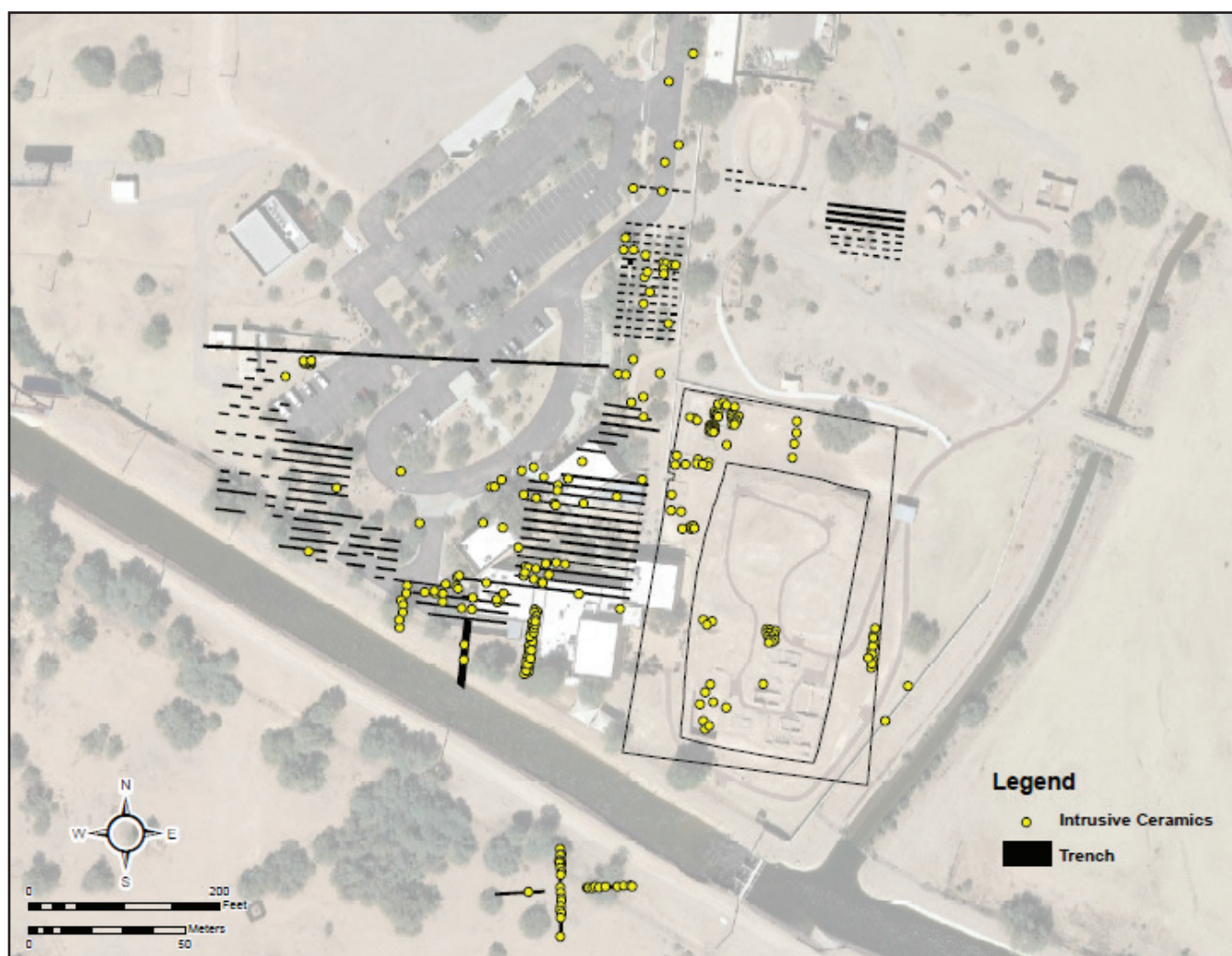


Figure 4. Locations where nonlocal sherds were found at PG Park.

sociated with the Ancestral Pueblo culture of Northern Arizona and was manufactured in the Hopi Buttes area south of the Hopi Mesas and in the Little Colorado River Valley (Douglass 1987:117). The earliest types of this White Ware date to the A.D 800s (Goetze and Mills 1993:41). Holbrook Black-on-white (AD 1025-1150; Sorrell et al. 2018) is the most common nonlocal type at PG Park. Holbrook Black-on-white is sometimes divided into two varieties: Variety A and B. The former is similar to a Black Mesa style but with Little Colorado White Ware technology, while the latter is more like the Sosi style (Dittert and Plog 1980:90). Our study found only one Type A sherd. Others were not distinguishable as to A or B. Walnut Black-on-white, which dates from AD 1150-1225 (Sorrell et al. 2018), is also common in this collection.

Little Colorado White Ware was particularly prevalent in the SR 143 collection, where there were 54 specimens identified – more than from the PG Park collection. Little Colorado White Ware also occurred more frequently in non-mound areas, although the prevalent types here date a little later than did the Tusayan White Ware, the latter which ranged between AD 725-1250.

### Cibola White Ware

There are 36 Cibola White Ware sherds in the PG Park collection (8.0%). Most of these are Snowflake Black-on-white, which is known as a “catchall” type that is highly variable (Dittert and Plog 1980:87; Wood 1987:86). Cibola White Ware types were produced by Northern Mogollon and/or Southern Pueblo groups across a wide area of western-central New Mexico and

east-central Arizona (Wood 1987:83). Cibola is a ceramic expression that seems to incorporate both northern Mogollon and southern Pueblo groups. Eight Cibola White Ware sherds were found on the platform mound, and 28 were found in non-mound contexts, such as House 65 (n=1), east of Pithouse 2 (n=1), Trash Mound 3 (n=1), roadway excavations (n=6), test units in the field school area (n=8), pit fill (n=2), or in places where specific context and provenience information was not available or recorded.

A narrow corridor along Washington Street north of the PG Park, but not within the SR 143 project area, was excavated for the Metro Light Rail project. This excavation found approximately 61 Snowflake Black-on-white sherds – all from the same vessel –with an infant burial (Ferguson 2007:Table 17.1).

### San Francisco Mountain Gray Ware

San Francisco Mountain Gray Ware was produced between AD 750/800 to 1100 by the Cohonina Culture of northern Arizona – a culture that lived on the Coconino Plateau in an area that extends from south of the Grand Canyon to Flagstaff and Williams (Colton 1958). Clay is believed to have been obtained from a source at the base of the Grand Canyon (Alan P. Sullivan, personal communication 2017). San Francisco Mountain Gray Ware is absent from the SR 143 project, yet nine sherds of this Gray Ware were recovered from the PG Park (2.0%). These include four Deadman’s Black-on-gray (AD 1025-1175) (Downum 1988) and five Floyd Black-on-gray, the latter type which dates from AD 800-1025 (Sorrell 2005).



Figure 5. Tusayan White Ware vessels. Left: Kana-a Black-on-white jar from feature HC 128; Right: Black Mesa Black-on-white jar with handles that look similar to parrot heads. Illustrations by Jonathan Joha.



### Lower Colorado Buff Ware

Consisting of plain buff, red-slipped buff, and red-on-buff types, this ware is associated with the Lowland Patayan along the lower Colorado River and was originally described by Rogers in the 1940s and then, later, inconsistently described by Schroeder who apparently overemphasized temper in identifying specific types (cf. Waters 1982). These ceramics were manufactured by paddle and anvil (Beckwith 1988; Schroeder 1958; Waters 1982) from AD 700 or 800 to 1900+. Lower Colorado Buff Ware sherds are more common in the SR 143 collection, with 15 sherds recovered (6.0%), compared to only 5 sherds found in the PG Park collection (1.1%). Thus, only 20 Lower Colorado Buff Ware sherds have been recovered from Pueblo Grande. However, one of the whole vessels in the PG Park collection is a Tumco Buff jar from a cremation burial (HC101) located about 45 m west of the platform mound. This vessel was placed in an ovoid burial pit and served as a cremation urn with a bowl cover (Brunson-Hadley 1994). The age and sex of the cremated individual is unknown.

### San Juan Red Ware

San Juan Red Ware was made in the San Juan River drainage area of the Four Corners region and dates from AD 750 to 900 (Christenson 1994). This ware represents one of the earliest of the Ancestral Pueblo pottery making traditions. No sherds from this ware were found in the SR 143 project, possibly because it is an early type. San Juan Red Ware represents less than eight percent of the PG Park pottery assemblage, but a whole Bluff Black-on-red jar was found with an infant cremation burial (HC39) in a bi-lobed, double pit located about 20 m west of the platform mound (Brunson-Hadley 1994). This vessel is shaped like a large gourd with a handle and has coarse angular quartz sand temper and a surface that was polished after being painted, creating a sheen (Figure 6).

### Central Arizona Ceramic Tradition

The Central Arizona Ceramic Tradition appears to represent an amalgamation of different pottery-making traditions that evolved into a distinctive style of ceramics in the Hohokam Classic period, which has been named variously as Roosevelt Red Ware, Salado Red Ware, and Salado Polychromes (see Lindauer [1998] for an in-depth discussion of these ceramic classifications). PG Park collection sherds that share some stylistic and geographic characteristics with the Salado Polychromes, but are not actual polychromes, were grouped into this category of "Central Arizona Ceramic Tradition."

Frequencies in Central Arizona Ceramic Tradition pottery from PG Park and SR 143 are relatively close – from PG Park there were 21 sherds (4.7%) and from SR 143 there were 15 sherds (6.0%). Among this ware were two perforated plate fragments, classified as Tonto Brown, in the PG Park collection. One of them was found near the Platform Mound and the other was from an unknown

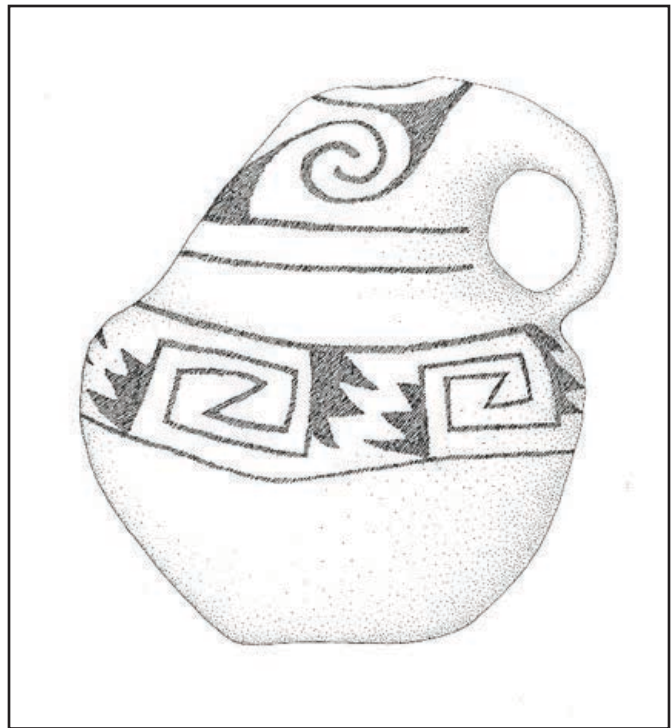


Figure 6. Bluff Black-on-red jar shaped like a gourd. Illustration by Jonathan Joha.

location, but these two sherds may represent a single vessel. Perforated plates have a series of small holes that encircle the plate near its rim. These unusual ceramics are reportedly associated with Kayenta groups (Lyons 2003). Based on residues, use wear, and contextual data, Lyons and Lindsay (2006) argue that perforated plates were used as base mold or turntables for pottery making by immigrant groups from Northern Arizona and as such are linked to the spread of the Salado phenomenon.

### Zuni-Acoma Glaze Ware

Zuni-Acoma Glaze Ware was made by the Cibola tradition of the Ancestral Pueblo in the southern Colorado Plateau region (Southwest Ceramic Typology website). Two sherds were identified as Zuni-Acoma Glaze Ware in the PG Park collection, both of which are Heshotauthla Polychrome (0.4%). According to Huntley (2008), Zuni Glaze Ware is thought to be related to White Mountain Red Ware, which was made during the early Pueblo IV period. Heshotauthla Polychrome is typically found in bowl forms, which are slipped bright red or orange on both the interior and exterior with glaze-painted interior design and thin-lined, white geometric exterior designs. Heshotauthla Polychrome was made between AD 1275 and 1400 (Huntley 2008:21-22).

### White Mountain Red Ware

White Mountain Red Ware consists of a group of polychrome and painted red ware ceramics produced in east-central Arizona and western New Mexico be-



tween AD 1000 and 1500 by the Ancestral Pueblo tradition (Carlson 1970; Colton and Hargrave 1937). Pottery types of the White Mountain Red Ware are the most abundant and widely distributed Ancestral Pueblo ceramics (Dittert and Plog 1980:98). White Mountain Red Ware is stylistically and technologically similar to Cibola White Ware and has many local regional variations that are believed to have originated in late Mogollon and early Pueblo communities (Carlson 1970; Wood 1987:90). White Mountain Red Ware has a thick red slip and hard coarse paste (Hays-Gilpin and van Hartesveldt 1998:141). Paint is black or black and white on a red-slipped background, and can be mineral or organic (Hays-Gilpin and van Hartesveldt 1998). Dittert and Plog (1980:99) argue that all of the design characteristics of White Mountain Red Ware existed previously in the Cibola White Ware region, with the addition of a red slip.

Thirteen White Mountain Red Ware sherds (2.9%) are in the PG Park collection, consisting of Pinedale Black-on-red (n=7), Pinedale Polychrome (n=2), Fourmile Polychrome (n=3), and unidentified White Mountain Red Ware (n=1). They are associated with the Platform Mound and away from it. The SR 143 collection also contained six White Mountain Red Ware sherds (Foster 1994). Breternitz (1966) provides date ranges for the following types: AD 1275-1350 for Pinedale Black-on-red and Pinedale Polychrome and AD 1325-1400 for Fourmile Polychrome.

### **Jeddito Yellow Ware**

Jeddito Yellow Ware was one of the most widely distributed ceramic wares in the late prehistoric period of the American Southwest (Schaefer 1969). An Ancestral Pueblo pottery-making tradition, Jeddito Yellow Ware appears to have first been produced around AD 1325 or 1330 (Adams 2014) and was manufactured up to or past AD 1600 on the Hopi Mesas (Adams 2014; Colton 1956; Colton and Hargrave 1937; Dittert and Plog 1980). Jeddito Yellow Ware is very distinctive – the paste is made from a kaolin clay with a low iron content, which was fired with coal in an oxidizing atmosphere to create a yellow color and a very hard vessel (Shepard 1971:180-182). Jeddito Yellow Ware was made exclusively in at least five villages on the Hopi Mesas (Bernardini 2005:131) and, therefore, “its presence on sites away from the mesas can be read as a measure of contact – either direct or indirect – with Hopi producers” (Bernardini 2014:145).

Thirty-three (7.3%) Jeddito Yellow Ware sherds were found in PG Park, a relatively large quantity for a Hohokam site. These include Jeddito Black-on-yellow, Awatovi Black-on-yellow, and others that could not be identified specifically to either of these two types (Jeddito or Awatovi).

Most of the Jeddito Yellow Ware sherds in the PG Park collection were found associated with the platform mound and its Northwest Compound. Seven were

found in Room JH 44 on Floor 3, the uppermost floor located on top of a deposit of fill 1.5 m above Floor 2 (Downum and Hayden 1998:Figure 2.25) (Figure 7). The seven sherds may have come from the same vessel. Other nonlocal sherds found in an unknown location within the room include Black Mesa Black-on-white, Pinedale Polychrome, Kayenta Polychrome, and Tanque Verde Red-on-brown. The Kayenta Polychrome dates to AD 1250-1300. Nearly 100 Salado Polychrome sherds were also found in this room. Altogether, 9,846 sherds were reportedly collected from Room 44 (Downum and Hayden 1998:79).

Two other Jeddito Yellow Ware sherds were found in a room next door and another room in the Northwest Compound. Clearly, Room JH 44 and nearby rooms had access to high value ceramics obtained from sources located long distances from AZ U:9:1(ASM)/Pueblo Grande. Only four Jeddito Yellow Ware sherds were found in two habitation areas (HA 7 and HA 2) in the SR 143 portion of the site, further evidence of their primary association with the platform mound.

## **NONLOCAL CERAMICS FROM CANAL SYSTEM 2 VILLAGES**

AZ U:9:1(ASM)/Pueblo Grande is located at the headwaters of Canal System 2 or Turney's (1929) “Second Canal System” (cf. Henderson 2015). Canal System 2 contained more than four main canals that were built at a bend in the river south of AZ U:9:1(ASM)/Pueblo Grande. These canals trended northwesterly and linked with other major Hohokam settlements situated farther down the canal system. The major settlements consisted of villages with public architecture (platform mounds and ballcourts) surrounded by smaller settlements (hamlets, farmsteads, and field houses) and together formed what has been called an “irrigation community” (Doyel 1980; Gregory 1991:170). Settlements located within Canal System 2 include Pueblo Grande, La Lomita, La Lomita Pequeña, La Ciudad, Grand Canal Ruins, Casa Buena, Dutch Canal Ruin, and Las Colinas (Howard 1991; Turney 1929).

In the Classic period, three major settlement districts can be discerned on Canal System 2 – Pueblo Grande, La Ciudad, and Las Colinas (Figure 8). There is considerable debate about the sociopolitical organization of this system, but in order to operate effectively there would have had to have been cooperation among these settlements (Bostwick and Downum 1994; Cable and Mitchell 1991; Howard 1993; Nicholas and Neitzel 1984; Rice 2000; Upham and Rice 1980; Wilcox 1979). Therefore, it is worthwhile to compare the nonlocal ceramic assemblages for these settlement clusters, despite unevenness in settlement history and excavation intensity (see Table 5).

Building on a study by Doyel (1993) comparing nonlocal ceramics from Pueblo Grande, Las Colinas, and



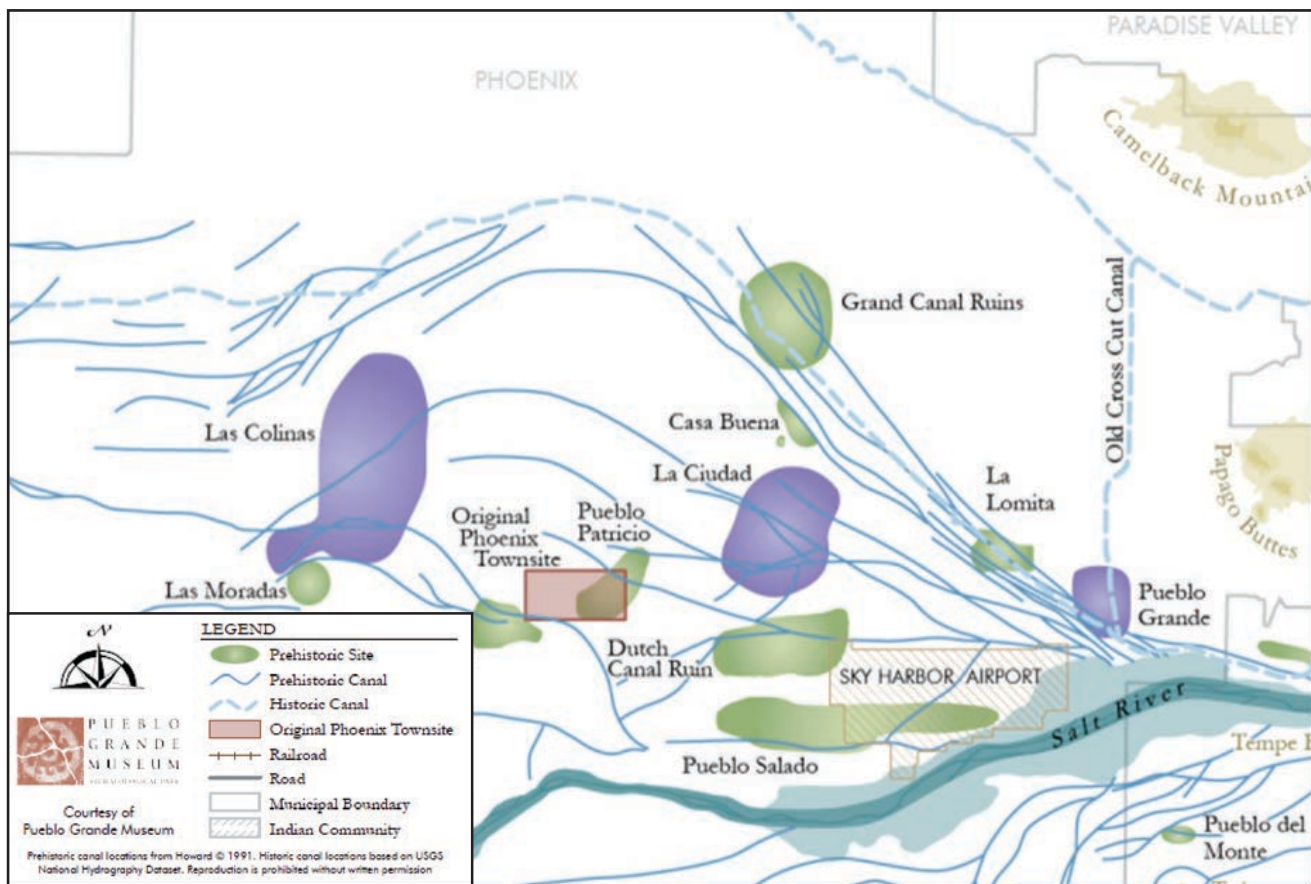


Figure 8. Major settlements along Canal System 2 including the sites of Pueblo Grande, La Ciudad, and Las Colinas.

La Ciudad – three Hohokam villages north of the Salt River along Canal System 2 – we added our ceramic data plus data from more recent work at La Ciudad for the Frank Luke Addition project (Garraty 2016). These data are listed in Table 5.

Pueblo Grande has the most diverse assemblage of these three important villages. La Ciudad and Las Colinas did not contain Zuni Glaze Ware or Winslow Orange Ware, although a Northwest Mexican/Sonoran ware was found at La Ciudad (Wilcox 1987:Table 4.3).

### AZ T:12:10(ASM)/Las Colinas

The largest collection of nonlocal pottery reported in the Phoenix region is from AZ T:12:10(ASM)/Las Colinas (Beckwith 1988; Crown 1981), located at the western end of Canal System 2 (5,627 sherds and 16 whole vessels). Las Colinas was a large Hohokam settlement that contained a ballcourt and at least five and possibly up to 10 platform mounds (Gregory et al. 1988; Hammack and Sullivan 1981).

Nonlocal ceramics at this site indicate interaction with three geographic regions – Northern, Southern, and Western Arizona. A wide variety of nonlocal ceramic types were recovered from the site (Table 2.13), which included 14 different ceramic wares and at least 51 different ceramic types (Beckwith 1988:224). The nonlocal

ceramics were associated with Ancestral Pueblo, Cohonina, Prescott, Mogollon, Tucson Basin, and Lower Colorado River groups. A preponderance of Lower Colorado Buff Ware – a total of 4,066 sherds and 12 whole vessels (in addition to more than 1,500 other nonlocal ceramics) – was found at AZ T:12:10(ASM)/Las Colinas with most of the Lower Colorado Buff Ware found at several houses in House Group 18 dating AD 1000-1150, west of Platform Mound 8. This concentration suggests a small enclave of Lower Colorado River Patayan populations at the site, perhaps two households with as many as 20 residents (Abbott et al. 2012:986; Beckwith 1988:224). Glen Rice (2000) has proposed that this enclave was recruited by the leaders of AZ T:12:10(ASM)/Las Colinas as laborers to help with irrigation duties. Interestingly, the Lower Colorado River pottery associated with the enclave at Las Colinas was not locally made, but was brought from elsewhere to the site, apparently by seasonal workers (Abbott et al. 2012:991; Beckwith 1988).

Dates for the Las Colinas nonlocal pottery assemblage range from AD 300 to AD 1600, but some of the ceramic types have wide date ranges, such as Forestdale Smudged (AD 300-1100) and Alma Plain (AD 300-1300), and it is likely that the earliest nonlocal ceramics probably date to *circa* AD 600 or slightly later (e.g., Lino Black-on-gray). In an early study of the Las Colinas ce-



ramics, Weed (1974) identified two sherds from Mexico, possibly from northern Nayarit or southern Sinaloa, but Crown (1981:144) was not able to relocate those sherds to confirm their identification. In comparison, three Ramos Polychrome, two Ramos Black, and one Chihuahua Plain Smudged (more likely Ramos Black) sherds were found in the PG Park collection, and two Carretas Polychrome sherds were found in the SR 143 collection.

Excluding the Lower Colorado Buff Ware, Tusayan White Ware are most common at AZ T:12:10(ASM)/Las Colinas, with similar frequencies as Pueblo Grande. Not all Tanque Verde Red-on-brown at Las Colinas were nonlocal – Weed (1974) suggests about half may have been locally made. This indicates that some individuals at Las Colinas may have come from the Tucson Basin. Fish et al. (1992:252) suggest that the locally made Tanque Verde Red-on-brown at Las Colinas may have been manufactured by “foreign” potters at the site.

### AZ T:12:1(ASM)/La Ciudad

Located in the middle of Canal System 2, AZ T:12:1(ASM)/La Ciudad had a ballcourt and two platform mounds (Rice 1987; Wilcox 1987). The site was first

excavated in the 1920s and mid-1930s (see Wilcox 1987). The nonlocal ceramics were later analyzed by T. Kathleen Henderson, Jo Ann Kisselburg, Alfred E. Dittert, Jr. and David R. Wilcox in 1983 (Wilcox 1987:Table 4.3). A small number of nonlocal ceramics recently recovered from an excavation at La Ciudad (Garraty 2016) are also included in this analysis.

Most of the excavations at AZ T:12:1(ASM)/La Ciudad have examined Pre-classic site components. A smaller quantity and variety of nonlocal ceramics were found at this site than at Las Colinas and AZ U:9:1(ASM)/Pueblo Grande. The La Ciudad assemblage included 15 wares and 51 types, not including an additional 8 Salado Red Ware ceramic types. Not surprisingly, Tusayan White Wares (n=39) were the most common nonlocal ceramics at AZ T:12:1(ASM)/La Ciudad. Those sherd counts were followed by Tucson Basin (n=19), Little Colorado White Ware (n=19), and Cibola White Ware (n=19). San Juan Red Ware, San Francisco Mountain Gray Ware, Alameda Brown Ware, Mogollon Brown Ware, Lower Colorado Buff Ware, and Northwest Mexico/Sonoran Ware sherds were also recovered from the site. Some of the black-on-white sherds and “dull black-on-gray” sherds were found in a stratigraphic test of Platform Mound A (Wilcox 1987:Table

4.7). Similar to Pueblo Grande and Las Colinas, both early (Kana-a Black-on-white) and late (Jeddito Yellow Ware) nonlocal ceramic types are present. A small number of Lower Colorado River Buff Ware sherds also were recovered during recent excavations at the site (Garraty 2016:Table 1.12).

Similar nonlocal pottery types to those found at Pueblo Grande have been identified at other sites associated with Canal System 2, but in smaller quantities and with less variety of wares. The two settlements on each end of Canal System 2 – Pueblo Grande, located at its headwaters, and Las Colinas, located at its terminus – had the largest and greatest variety of nonlocal ceramics. Pueblo Grande may have been a destination and trading center while Las Colinas competed with Pueblo Grande for status and influence (Rice 2000).

Located in proximity to the head waters, Pueblo Grande probably controlled much of the water that flowed to the thousands of acres of crops on which the occupants of the other sites relied for their subsistence. This potential control of a critical resource gave Pueblo Grande special status and influence over other Hohokam settlements, possibly attracting traders and providing means to acquire ceramics from long distances. Pueblo

**Table 5. Presence-Absence of nonlocal pottery wares by village site.**

Ware	Site		
	Pueblo Grande	La Ciudad	Las Colinas
Alameda Brown Ware	X	X	X
Central Arizona Ceramic Tradition*	X		
Cibola White Ware	X	X	X
Jeddito Yellow Ware	X	X	X
Little Colorado White/Gray Ware	X	X	X
Lower Colorado Buff Ware	X	X	X
Mogollon Brown Ware	X	X	X
Northwest Mexico/Chihuahua wares	X		
Northwest Mexico/Sonora wares		X	
Prescott Gray Ware	X		X
San Francisco Mountain Gray Ware	X	X	X
San Juan Red Ware	X	X	X
Tizon Brown Ware			X
Tusayan White/Gray Ware	X	X	X
Tucson Basin/San Carlos Red-on-Brown Ware	X	X	X
Tsegi Orange Ware	X	X	X
White Mountain Red Ware	X	X	X
Winslow Orange Ware	X		
Zuni Glaze Ware	X		

Note: \* - This ware category may not have been in use at the time of analyses at AZ T:12:10(ASM) and AZ T:12:1(ASM).



Grande's importance is reflected in its massive platform mound, perhaps the largest Hohokam platform mound ever built.

## DISCUSSION

A wide variety of nonlocal pottery types have been identified at Pueblo Grande Archaeological Park, representing 18 wares and 61 types. This nonlocal pottery was acquired from several different cultural groups including the Kayenta, Little Colorado, and Cibola branches of the Ancestral Pueblo, Mogollon, Cohonina, Prescott, Tucson Basin, and Northern Mexico. Non-local pottery was likely transported along natural travel corridors that followed the Gila River and its major tributaries (Salt River, Verde River, Agua Fria River, San Pedro River, and Santa Cruz River) as well as other well-established trade routes (Colton 1941; Crown 1984:Figure II.7.12; Doyel 1991:Figure 10.2).

Nonlocal ceramics at Pueblo Grande occur in contexts dating from the Hohokam Colonial through Classic periods, with most sherds recovered from Hohokam Sedentary period contexts. Northern Arizona nonlocal pottery was most common at Pueblo Grande during the pre-Classic period, especially Tusayan White Ware. During the Classic period, nonlocal wares such as Jeddito Yellow Ware and Tucson Basin wares are predominantly, but not exclusively, from the Pueblo Grande platform mound. Tanque Verde Red-on-brown sherds at Pueblo Grande are primarily small jars or bowls that were not manufactured locally but were obtained from several different sources in the Tucson area. This suggests that Pueblo Grande maintained trade relationships with several different settlements along the flanks of the Tortolita and Tucson Mountains in the Tucson Basin.

Most nonlocal pottery forms at Pueblo Grande are bowls. Whittlesey (1974) has suggested that bowls would have been preferred by traders because they can be nested, allowing multiple vessels to be carried at a time. Painted bowls may have been desired as imported vessels because they display designs that may have meanings important to those who serve food in the bowls. Small jars may have been incidental trade items filled with specific contents and brought along with a group of bowls (Baldwin 1976).

There are a variety of ways in which nonlocal pottery could have been obtained at Pueblo Grande. These include gift giving, barter, inheritance, gambling, or ceremonial retribution (Ford 1983; Snow 1973). Pottery may have moved across the landscape in down-the-line exchange, with mobile traders, or through direct procurement at the location in which it was manufactured. Tusayan White Ware appears to have been manufactured at the household level in the Kayenta region and distributed in low-level exchange systems (Kojo 1996). McGuire and Downum (1982) suggest that Kayenta pottery was traded into the Salt-Gila Basin in a down-the-

line network due to a correlation of Kayenta pottery with distance and a lack of correlation with site size. Groups in the upper Verde River region may have acted as "middlemen," acquiring Kayenta vessels and sending them south to the Hohokam; the absence of Hohokam ceramics in the areas north of Flagstaff suggests that the Hohokam did not themselves venture into these areas on a regular basis (Crown 1984:297).

Nonlocal pottery also may have been brought to Pueblo Grande by individuals attending or participating in potlucks, festivities or ceremonial events (Bayman 1994:71; Stark 1995:340). Doyel (1991:246) suggested that trade fairs and markets held at sites with ballcourts and plazas may have facilitated exchange. Acquisition of pottery, both local and nonlocal, may have taken place in markets associated with periodic games that took place in ballcourts (Abbott et al. 2007).

The Hopi, Mexican, and many of the polychrome bowls at Pueblo Grande may have been obtained by high ranking individuals associated with the platform mound and used as a marker of their status (Foster 1994:159). Ceramics from northwest Mexico and the northern Chihuahuan Desert region are rarely found at Hohokam sites in the Salt River and their presence at Pueblo Grande may have held special significance (Nelson 1986). Crown (1984) and Beckwith (1988:239) suggested that nonlocal ceramics at Hohokam sites represented high intrinsic value items. These vessels could have been used in feasting activities that were part of ceremonies located within, or sponsored by individuals associated with the platform mound. White Mountain Red Ware bowls, with their striking visual designs, appear to have served as containers for feasting in the Southwest beginning around AD 1150 (Van Keuren 2004, 2011). Feasts involve the sharing, consumption and discard of food and drinks (Mills 1999; Potter 2000). The Pinedale Black-on-red, Pinedale Polychrome, and Fourmile Polychrome vessels at Pueblo Grande could have been used in communal feasts with socially integrative functions, encouraging social cohesion, or in cementing political ties and creating obligations (Phillips and Sabastian 2004). Several large, finely made red ware bowls, 25 to 51 cm in diameter, were recovered from the platform mound that may have used for feasting activities (Bostwick and Downum 1994:371-372). In addition, several clay comales, likely used for making tortillas, are associated with the platform mound.

Crown (1984, 1985) and Doyel (1993) examined Hohokam inter-regional ceramic exchange and they found that a wide variety of non-Hohokam pottery came into the Phoenix region from many directions, "but it did not enter in great quantity" (Doyel 1993:458). Nonetheless, as many as 90 different pottery types and numerous wares have been recorded from various Hohokam sites (Crown 1984; Doyel 1989, 1993). Similar to the nonlocal ceramics found at Pueblo Grande, only a few nonlocal ceramic types are represented by more than

**Table 6. Nonlocal Pottery Types from the Pueblo Grande Platform Mound Complex.**

Ware	Type	Location*	Total Number of Sherds
Alameda Brown Ware	Winona Corrugated	Northwest Compound, Court F	2
Central AZ Ceramic Tradition	1 Tonto Corrugated, 1 Salado Red	Northwest Compound, Room 42	2
Cibola White Ware	6 Snowflake Black-on-white (1 Room 42, 2 Room 47), 1 unidentified type, 1 Reserve Black-on-white (Room 47)	Northwest Compound Platform mound, Rooms 42, 47 on mound	8
Hohokam Buff Ware	Tanque Verde Red-on-brown (2 indeterminate)	Northwest Compound Courts C, E, F, Platform mound, Room 4, 24	40
Jeddito Yello Ware	9 Jeddito Black-on-yellow, 2 Awatovi Black-on-yellow, 1 Bidahochi Polychrome, 1 Homolovi Polychrome, 6 Awatovi/Jeddito Black-on-yellow	Northwest Compound Court A, Platform mound Room 42, 44, 47, 48, 56, 57, 62, 63	19
Indeterminate	Indeterminate Corrugated	Northwest Compound Court F, Platform mound	3
Mogollon Brown Ware	4 Linden Corrugated, 1 Reserve Plain Smudged	Platform mound, Room 44, 47	5
San Francisco Mountain Gray Ware	Floyd Black-on-gray	Platform mound	1
Tsegi Orange Ware	2 Tusayan Black-on-red, 1 Kayenta Polychrome, 2 Medicine Black-on-red	Platform mound, Room JW1, 44, 46	5
Tusayan White Ware	2 Kana-a Black-on-white, 1 Black Mesa Black-on-white, 1 Sosi Black-on-white, 1 Indeterminate	Platform mound, Room JW1, 44, 46	5
White Mountain Red Ware	1 Four-Mile Polychrome, 2 Pinedale Black-on-red	Platform mound, Room 44	3
Zuni-Acoma Glaze Ware	Heshotauthla Polychrome	Platform mound	1
Little Colorado White Ware	Holbrook Black-on-white	Platform mound Room 19	1
San Juan Red Ware	Deadman's Black-on-red	Room (unknown)	4
Total			99

Note: - \*Location is in respective order as type where applicable.

a few sherds at the majority of Hohokam sites (Doyel 1993:459). This indicates that although the ceramic exchange networks were diverse and far reaching, only small numbers of nonlocal ceramic vessels were acquired annually by the Hohokam. Combining Doyel's (1993) data with those from SR 143, Foster (1994:163) estimated that no more than four or five nonlocal vessels were imported to the site of Pueblo Grande per year. Whether this pottery was brought to the site by people affiliated with other socio-political groups or was acquired by Hohokam individuals during excursions to outlying areas is unknown. As Foster (1994:164) noted, the low number of nonlocal vessels suggests there was not "an organized, systematic, intense exchange for nonlocal vessels at the site." Nonetheless, pottery manufactured in various distant locations made its way to Pueblo Grande over the course of its lengthy occupation, indicating that non-local pottery held some social, political, and/or ritual significance.

The Pueblo Grande pottery assemblage predominantly consists of sherds, and it is not possible to state with confidence that each sherd represents an entire vessel that was traded into Pueblo Grande. Crown (1984:289) noted that many of the nonlocal sherds at Las Colinas "may have been originally brought to the site as sherds rather than as vessels." However, Beckwith (1988:256) estimated the number of whole vessels at Las Colinas based on the quantity of sherds, suggesting that 1,341 sherds represented a minimum of 1,054 vessels. We are not so confident with this sherd-to-vessel ratio to conduct a similar exercise with the combined 674 sherds recovered from PG Park and SR 143 portions of Pueblo Grande. Data from unpublished excavations at Pueblo Grande will undoubtedly raise this number if and when they become available.

Sherds could have been curated by ethnic groups that came to visit or stay at Pueblo Grande or they may have been picked up by Pueblo Grande inhabitants dur-

ing travels and forays (Crown 1984:289). The sherds themselves may have had significant meaning to the inhabitants of Pueblo Grande, representing “pieces of place” with social value because of their geographic importance rather than from their original use as vessels (Spielmann 2002, 2004). Alternatively, the sherds at Pueblo Grande may represent the remains of vessels that were broken during use or intentionally when a domestic or ritual space was abandoned, with a portion of the vessel left behind as part of a closing ceremony. For example, seven Hopi yellow ware sherds apparently from the same vessel were found on the uppermost floor of a room (JH 44) in the northwest compound of the platform mound and this floor was located on top of a thick deposit of Pre-classic period trash that appears to have been used to almost completely fill in the room. An unusual red-colored stone axe and a cache of 45 obsidian nodules were present within the room fill and under the upper floor. The excavator of Room JH44, Julian Hayden, reported in his field notes that two Jeddito Black-on-yellow sherds from the same vessel in Room JH44 were also found on the floor of Room JH42, an adobe room just north of Room JH44 (Downum and Hayden 1998:79).

## CONCLUSIONS

The results of our study of the nonlocal pottery at PG Park are mostly consistent with patterns seen at other Hohokam village sites (Beckwith 1988; Crown 1984; Doyel 1991). A variety of nonlocal pottery types first occurs in the Colonial period and peaks during the Sedentary period, with Tucson Basin red-on-brown and Hopi Yellow Ware especially common during the Classic period (Crown 1984:281). The nonlocal pottery assemblage at Las Colinas, located at the end of Canal System 2, is relatively similar to the pottery from Pueblo Grande at the head of the same canal system, more than 6 miles (9.6 km) apart. Each site has been only partially excavated, yet each contained a wide variety of pottery types representing extensive trade networks, with the most frequent nonlocal pottery found in Sedentary period contexts (Beckwith 1988:256). All four of the whole nonlocal vessels at the PG Park are from cremation burials, three of them with humans and one with multiple sets of bighorn sheep horns and various ritual items. In addition, the two whole nonlocal vessels from SR 143 project area at Pueblo Grande also were found in mortuary contexts. At Las Colinas, most of the whole nonlocal vessels were found with cremations and Beckwith (1984:239) noted that this association “argues for the inherent value of the vessels and demonstrates one of their primary functions in Hohokam society.”

In conclusion, our study has finally made available data on nonlocal pottery from the PG Park obtained from legacy projects, some of which were undertaken more than 75 years ago. This data demonstrates the val-

ue of legacy collections and the contributions they can make to our understanding of past cultures.

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# EVALUATING HABITATION SITE LOCATIONS OF VIRGIN BRANCH ANCESTRAL PUEBLO SETTLEMENTS BY UTILIZING CUMULATIVE VIEWSHED ANALYSIS

Marty Kooistra

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*Prehistoric habitation sites located in the Mount Trumbull region of northwest Arizona are constructed across a diverse topographic landscape. Several archaeological site reports for the Mount Trumbull region allude to the exceptional views from these structures despite their often-inconspicuous locations. This study utilizes Geographic Information Systems (GIS); Cumulative Viewshed Analysis (CVA); and site suitability analysis to facilitate understanding of patterns and relationships among archaeological habitation sites located in this exceptionally diverse landscape. Using CVA, the study seeks to characterize habitation sites as linked in two ways. The first is geographic. Are habitation sites intervisible? The second means of connection concerns material remains. If the CVA is limited to sites containing corrugated ceramics, a temporal marker of Pueblo II period occupation, can a deeper connection be inferred? Based on results from several viewshed analyses, data suggest that the placement of known habitation sites across the landscape significantly differs compared to random "non-site" locations. The data indicate that building of habitations, by Ancestral Pueblo people resulted from planned construction in areas favoring overall intervisibility.*

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The prospective views to and from archaeological sites have long been of interest to archaeologists for their potential importance in explaining the placement of cultural features within surrounding landscapes. In recent years, advances in Geographic Information Systems (GIS) technology have provided archaeologists with the ability to reconstruct views to and from cultural features where first-hand observation may not be economically feasible or logistically possible using viewshed analysis. Previous visibility-focused GIS analysis that explore archaeological phenomenon assume the investment in constructing sites at various positions across the archaeological landscape was influenced by: the need to signal to people moving through the landscape, for defensive purposes, to manage access to resources,

or to serve some social or ritual purpose (Bongers et al. 2012; Comer et al. 2013; Doyle et al. 2012; Johnson 2003; Jones 2006; Kantner and Hobgood 2016; Lambers and Sauerbier 2006; Philips et al. 2015; Reu et al. 2011; Smith and Cochrane 2011; Supernant 2014; Taliferro et al. 2010; and Van Dyke et al. 2016).

By utilizing cumulative viewshed analysis (CVA) and site suitability analysis, this study (Kooistra 2018; 2019) seeks to characterize archaeological habitation sites (i.e., incorporating pithouses, pueblos, and smaller 1-2 room structures) located near Mount Trumbull, Arizona as being linked in two ways. Are habitation sites intervisible? Further, based on their position within the landscape, are habitation sites intentionally constructed in certain areas or randomly positioned across the landscape? The second means of connection concerns material remains and aims to refine the first by limiting the CVA to habitation sites occupied during the Pueblo II and Pueblo III periods. If the CVA is limited to sites containing only corrugated ceramic ware, a temporal marker for Pueblo II and Pueblo III period occupation, can a stronger connection based on intervisibility be surmised? The research seeks to improve the current understanding of Virgin Branch Ancestral Pueblo settlement choice by determining if the placement of habitation sites results from random or planned construction.

Additionally, very few visibility-based analyses, except for those of Bongers et al. (2012), Johnson (2003), Lambers and Sauerbier (2006), and Smith and Cochrane (2011), have compared archaeological site locations to randomly generated non-site locations to evaluate if site placement was meaningful with respect to visibility or merely the result of random chance. Moreover, past research on intervisibility with the exception of Richards-Rissetto's (2010) has neglected to restrict testing non-sites to locations of the landscape that are comparable to known archaeological sites, bringing into

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question the significance of previous findings. The goal here is to address that deficiency by comparing known archaeological site locations to five sets of random non-sites that have been restricted by a site suitability analysis to areas of similar elevation, slope, and distance from known sites. I would argue that, at the small-scale community level, communication influenced the decision to build habitation sites in specific areas of the landscape while neglecting others. Habitation sites within the Mount Trumbull area have been constructed to see and to be seen by others in this topographically diverse landscape. To see involves a subject acting as the viewer gazing outward at something or someone, such as nearby habitations. To be seen, by contrast, involves the deliberate act of making a place visible to others, often within the context of monumental architecture (Van Dyke et al. 2016:206).

I hypothesize that Virgin Branch Ancestral Pueblo habitation sites are constructed in areas of the landscape that promote overall intervisibility. Further, if analysis is limited to habitations that contain corrugated ceramic ware (an indication of Pueblo II and Pueblo III period occupation), a significant statistical difference should exist confirming the primary hypothesis. Based on these hypotheses, three possibilities exist for explaining Virgin Branch Ancestral Pueblo settlement within the Mount Trumbull region: (1) prehistoric settlements within the study area are constructed in locations across the landscape that favor intervisibility for functional purposes (e.g., communication, defense, monitoring of resources or trade), (2) intervisibility can help to predict material similarity, or (3) maintaining intervisibility was unimportant.

The Mount Trumbull study area (Figure 1) is part of the Uinkaret Plateau, a sub-plateau of the much larger Colorado Plateau that encompasses approximately 10,000 acres in northwest Arizona. The Uinkaret Plateau is located on the Arizona Strip and is part of the Grand Canyon-Parashant National Monument, considered one of the most remote places within the 48 contiguous states.

The choice of Mount Trumbull as a research locale is motivated by the region's diverse topography. The spectacular view from many archaeological sites, prehistorically occupied by the Virgin Branch Ancestral Pueblo peoples, urges consideration of what their world was like, as many habitation sites stand on what modern civilization would consider "prime real-estate." The importance of visibility to the prehistoric occupants of the area is evidenced by archaeological site reports for the Mount Trumbull study locale that allude to the spectacular views from various habitation structures. The following four site descriptions, taken directly from Arizona State Museum site cards, reference the picturesque landscape: "(AZ A:12:28[ASM]) The site is a small unit pueblo of possibly 5 or more rooms [...] situated on the eastern edge of a shelf commanding excellent views

east, southeast, and northeast"; "(AZ A:12:325[ASM]) The rooms arc to the northwest in a partial C-shape situated on the eastern edge of a steep hillside that commands an excellent view east, southeast and northeast"; "(AZ A:12:384[ASM]) The site is located on the highpoint of a ridge a good vantage point for views to the west, east and south"; and "(AZ A:12:445[ASM]) The pueblo occupies a dramatic location perched on the crest of a knoll overlooking a saddle to the north and providing a 360-degree view of the surrounding terrain".

## THE ANCESTRAL PUEBLO OF MOUNT TRUMBULL

While the Virgin Branch Ancestral Pueblos of Mount Trumbull remain one of the least studied and understood Puebloan cultural groups, several chronological models have been composed to chronicle Ancestral Pueblo cultural development. The most prevalent of these models is the Pecos Classification, devised in 1927 (Kidder 1927; Lyneis 2000). As Altschul and Fairley note, "before the mid-1920s, archaeologists were forced to rely exclusively on stratigraphic evidence to place their assemblages in chronological order, since absolute dating methods had not yet been developed" (Altschul and Fairley 1989:55). Consequently, chronological periods for the Ancestral Pueblo originate from the Pecos Classification, which identified eight temporal phases (Basketmaker I through III and Pueblo I through V) according to changes in architecture, art, and ceramics (Altschul and Fairley 1989; Kidder 1927; Lyneis 2000) based on then-current archaeological understanding. The Pecos Classification was expected to apply to the entire southwest; however, further research indicated the classification did not accurately represent the Ancestral Pueblo as a whole.

As the decades progressed an assortment of chronological schema were proposed for the Formative Period with several archaeologists devising descriptive schemes to describe the region's prehistory (Colton 1939; Altschul and Fairley 1989:55; Reed 1946, Shutler 1961). This study utilizes a modified chronology presented by Altschul and Fairley (1989:105) for the Arizona Strip that is based loosely on the Pecos Classification. Altschul and Fairley divides the occupation of the Arizona Strip into eight phases: Basketmaker II (300 BC - AD 400), Basketmaker III (A.D 400-800), Early Pueblo I (AD 800-900), Late Pueblo I (AD 900-1000), Early Pueblo II (AD 1000-1050), Mid-Pueblo II (AD 1050-1100), Late Pueblo II (AD 1100-1150), and Early Pueblo III (AD 1150-1255).

Occupation of the Uinkaret Plateau during Pueblo II is believed to have coincided with what is referred to as the "Great Drought," hypothesized to have lasted 35-50 years (Buck and Sabol 2014:65). The Great Drought, referenced by Buck and Sabol, also afflicted the Four Corners region during the late thirteenth cen-

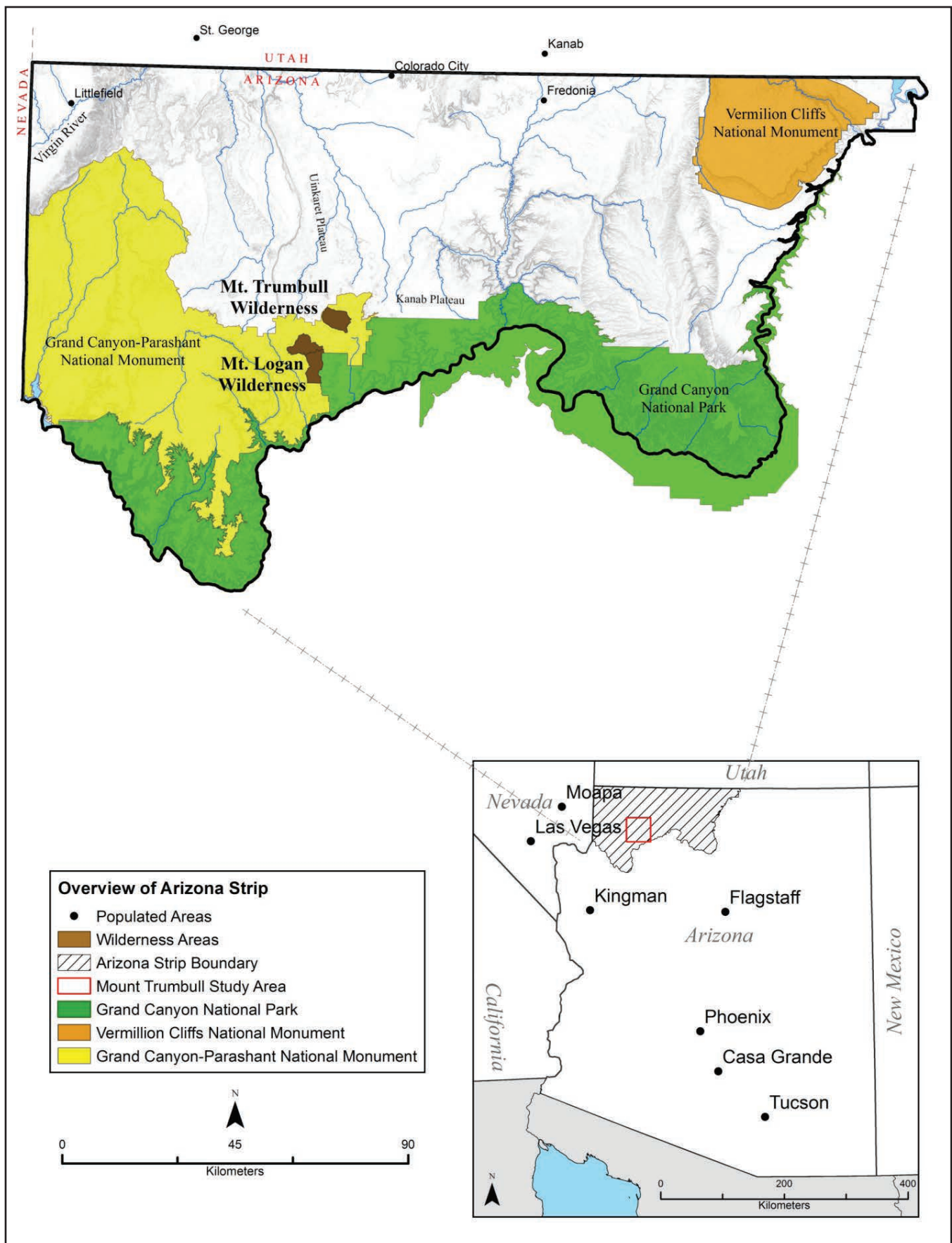


Figure 1. Map of the Arizona Strip and Mount Trumbull study area located in northwest Arizona.



tury (Woodhouse and Overpeck 1998: 2702). Other droughts likely occurred during Basketmaker II-Pueblo III times, ranging from 10-20 years, but it is believed that the "Great Drought" ultimately led to depopulation during late Pueblo II into Pueblo III times. The research presented in this study primarily focuses on the Pueblo II period, which is recognized as a time of intense Ancestral Puebloan occupation within the Arizona Strip and surrounding areas and which accounts for the majority of archaeological sites within the Virgin Branch Ancestral Pueblo region. Altschul and Fairley (1989:128) contend that the increased occupation during the Pueblo II period resulted from improved climatic conditions that made agriculture possible in previously unproductive upland regions. Scattered terraced garden plots provide evidence of this, along with check dams and other agricultural features (Euler 1979; Schwartz et al. 1981). Other hypotheses include in situ population growth and in-migration from neighboring regions (Aikens 1966; Efland et al. 1981). Additionally, Pueblo II period artifact assemblages exhibit an increase in quantity and quality of ceramics and stone implements, suggesting a greater reliance on agriculture at this time (Allison 1996; Larson 1996; Myhrer 1986).

The most significant ceramic change associated with the Pueblo II period is the introduction of corrugated ceramic ware. Altschul and Fairley note that, "the relative frequency of corrugated to plain wares [is] important for determining the temporal placement of sites throughout the Arizona Strip during the Pueblo II and early Pueblo III periods" (Altschul and Fairley 1989:128-129). Due to the overall lack of radiocarbon dates and re-occupation of pre-existing sites spanning multiple periods, it is difficult to demonstrate contemporaneous occupation of habitation sites. For example, several sites contain artifacts from Basketmaker II through Pueblo III times, suggesting continuous or at least intermittent occupation. For this reason, two datasets are analysed here – the record dataset containing 320 habitation sites ranging from the Basketmaker II to Pueblo III period, and a corrugated dataset containing 134 habitation sites. The corrugated dataset is limited to sites that contain corrugated ceramic ware, a temporal marker for the Pueblo II and Pueblo III periods.

## METHODS OF SPATIAL ANALYSIS

Viewshed analysis is the primary approach used in this study to compare Virgin Branch Ancestral Pueblo habitation sites. The standard viewshed function is part of the Spatial Analyst Toolbox in the popular ArcGIS software application developed by Environmental Systems Research Institute (ESRI). Additionally, GRASS GIS, an open source GIS software application was utilized to generate cumulative viewsheds. CVA produces a map of intervisibility between viewpoints and all other points of a Digital Elevation Model (DEM). When applied to

archaeological habitation sites as the originating viewpoints, CVA is beneficial for modelling the way ancient people may have understood and used a landscape (Ullah 2015:341).

### Viewshed and Cumulative Viewshed Analysis

Viewshed analysis in brevity calculates the field of view from an observation point. To calculate a viewshed requires a set of viewpoints, which can be archaeological sites, cell phone towers, rock cairns, mountain peaks or any point corresponding to an area with varying degrees of elevation geographically tied to an x/y/z location. Viewpoints are typically stored in a GIS database as vector data and represent the observation locations for viewshed calculation. The second requirement for viewshed analysis is digital elevation data that contain elevation values associated with each raster cell. Raster data, in contrast to vector data, are continuous data that represent phenomena such as temperature, orthomosaic imagery, land cover, and specific to this study, elevation values, among a myriad of other potential phenomena.

In a DEM individual raster cells are assigned elevation values that, when combined, create a digital representation of the earth's surface. "The actual calculation [of a viewshed] requires that for each cell in the DEM, a straight line be interpolated between the source point and every other cell within the elevation model" (Wheatley and Gillings 2002:204-205). Based on elevation data embedded within a DEM, the height of all cells intersecting the line between the source and target cell can be obtained to ascertain whether any cells exceed the height of the three-dimensional line at that point (Figure 2). The procedure results in a binary variable (1= visible; 0= not visible) indicating which cells of the original raster surface are visible from the observer point (Fisher 1995:1298; Wheatley and Gillings 2002:205). In the resulting binary image, areas of the landscape with a direct line of sight from the target cell are coded as 1 and those with no line of sight as 0.

The standard viewshed function of GIS is ideal for investigating the visual properties of site locations. However, to examine intervisibility between a group of sites, the most valuable results are derived from generating viewshed maps for multiple sites and summing these maps to create a single surface. The process of combining viewsheds (Figure 3) is known as CVA and was first used by Wheatley (1995) to investigate barrows (burial mounds). "The cumulative viewshed surface then represents, for each cell within the landscape, the number of sites with a line of sight from that cell" (Wheatley 1995:173).

Once a cumulative viewshed surface has been created, it is then possible to perform a simple point selection within GIS to obtain for each site the number of other sites visible from its location. Another advantage of CVA is the ability to test the statistical significance of visibility by comparing the distribution of a sample da-

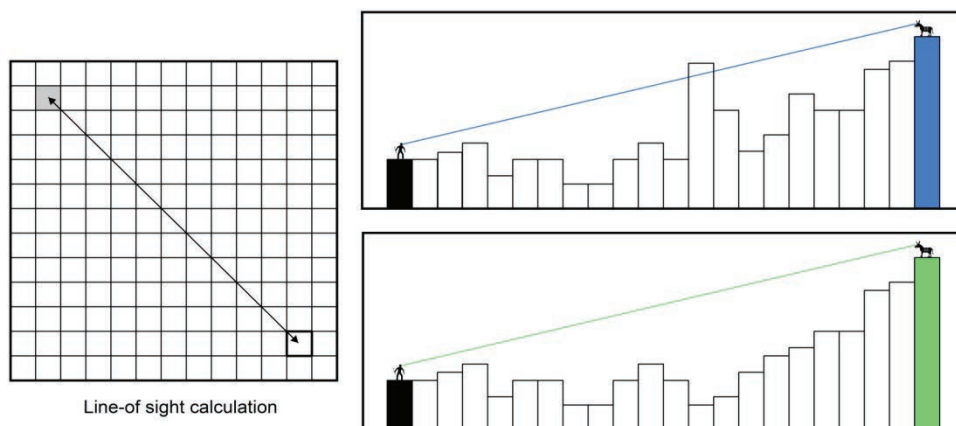
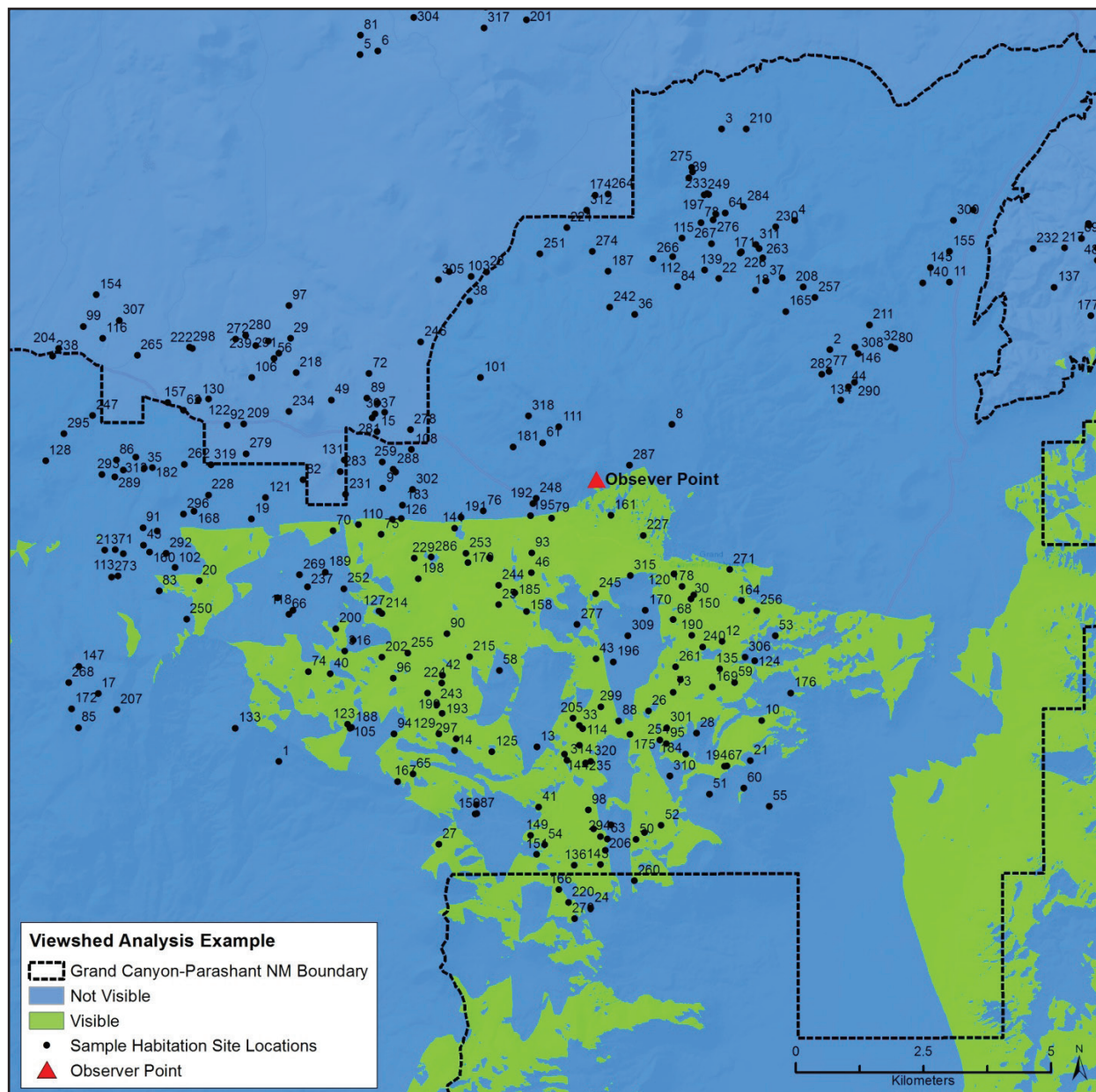


Figure 2. Simplified line of sight calculation. A line is interpolated between two cells in a DEM (left). If the height of neighboring cells does not cross this line (bottom right) there is a line of sight, if the height of any cell exceeds the height of the line (top right) then there is no line of sight (adapted from Wheatley and Gillings 2002:202).

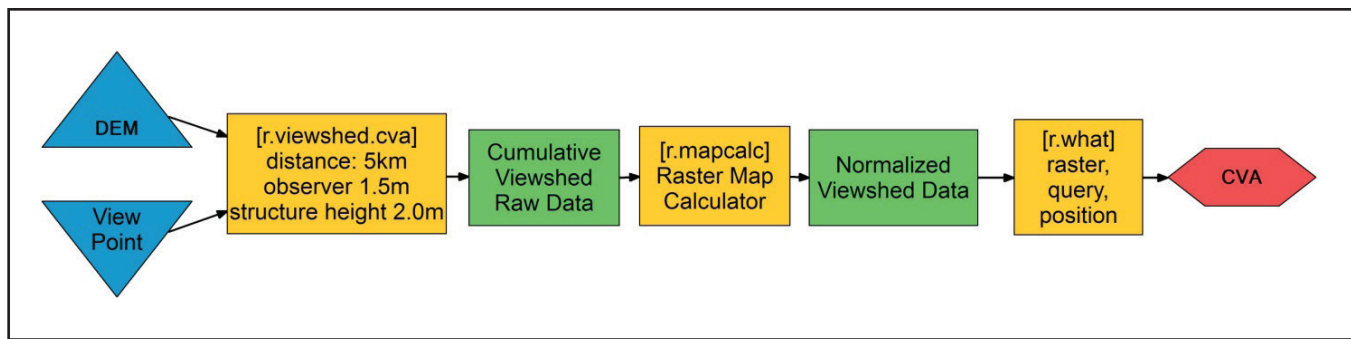


Figure 3. Spatial model of GIS steps for performing cumulative viewshed analysis using GRASS GIS 7.0.

taset with datasets of randomly distributed points using a one-way analysis of variance (ANOVA) or its non-parametric equivalent Kruskal-Wallis/Mann-Whitney (Fisher 1918; Theodorsson-Norheim 1986). The utilization of ANOVA or Kruskal-Wallis/Mann-Whitney can determine if archaeological sites were placed randomly throughout the landscape irrespective of visibility, or if sites were preferentially positioned in areas of high visibility. The benefit of GIS-based viewshed analyses is the ability to examine how prehistoric societies structured their world. Unfortunately, as with most methods of analyses, viewshed analysis is not without its shortcomings. A problem with GIS-based analyses that focus on computing binary viewsheds is that they indicate whether or not something could be seen within the parameters of a computer-based model, without addressing how well objects of interest could be seen in actuality over some distance. An unrestricted analysis could lead to an overestimate of visual significance, whereas a conservative (restricted) analysis could underestimate visibility (Richards-Rissetto 2010).

According to Ogburn, three main factors can impact visibility analysis: “the psychophysical limits of human vision, environmental limits, and the properties of objects and their surroundings” (Ogburn 2006:405-407). Prior to the viewshed analysis being carried out, consideration was given to the factors described by Ogburn, which carry the potential to represent visibility inaccurately. The physical boundaries of human vision are perhaps the most difficult to mitigate when using a computer model. However, one way to account for the limiting factor of human sight is by restricting viewshed distance. Several studies have employed viewshed limits, ranging from 5 km to 20 km to account for the limits of human visual acuity (Garcia-Moreno 2013; Gillings 2015; Kantner and Hobgood 2016; Van Dyke 2016). For the Mount Trumbull study area, a viewshed limit of 5 km was used. The choice of a 5 km limit is motivated by the fact that, at approximately that distance, the earth’s surface begins to curve out of sight (Wolchover 2012). The observer height was set to 1.5 m (4.92 ft). Although the stature of the area’s prehistoric residents would have varied, 1.5 m provides a standard baseline that

should represent most individuals. Lastly, a height of 2.0 m (6.56 ft) is used to represent habitation structures. All of the aforementioned parameters were applied to the viewsheds generated for known habitation sites and random non-site locations.

### Suitability Analysis

A site suitability analysis was performed in order to restrict the area where random non-site points would be generated to areas similar in composition to those of known habitation sites. This involved the use of a 10-m resolution DEM to calculate slope, elevation, and distance (Figure 4). All known habitation sites are in areas of less than 14.10 percent slope (flat areas). Thus, the first step for determining site suitability requires calculating slope from the DEM. Once slope has been calculated, a raster calculator is used to generate a polygon for areas of slope less than that amount. Additionally, known habitation sites are constructed between approximately 1,512 m and 2,286 m. Areas higher or lower in elevation contain no known sites. These unfavourable areas were presumably too cold during winter months for high-elevation or too hot during summer months for low-elevation settings. To limit random non-sites to areas of preferential elevation, a raster calculator was utilized to generate a polygon of areas lying between 1,512 m and 2,285 m. Finally, a buffer distance of 500 m from known habitation sites was used to limit the area where random non-sites could be generated. Without a buffer, random non-site locations are disproportionately scattered throughout the landscape, which could produce biased results.

The resulting polygons of: (1) ideal slope, (2) favorable elevation, and (3) buffer distance (Figure 5) were clipped. The outcome is a polygon of areas containing similar slope and elevation within a 500-m buffer of known habitation sites (Figure 6). Random non-sites were then generated for areas inside the polygon (Figure 7). To avoid potential false positive results, five sets of random non-sites ( $n=320$  and  $n=134$ ) were tested for comparison of each dataset. Figures 8 and 9 provide an example of cumulative viewshed results for  $n=320$  known-sites (Figure 8) and  $n=134$  known sites (Figure 9).



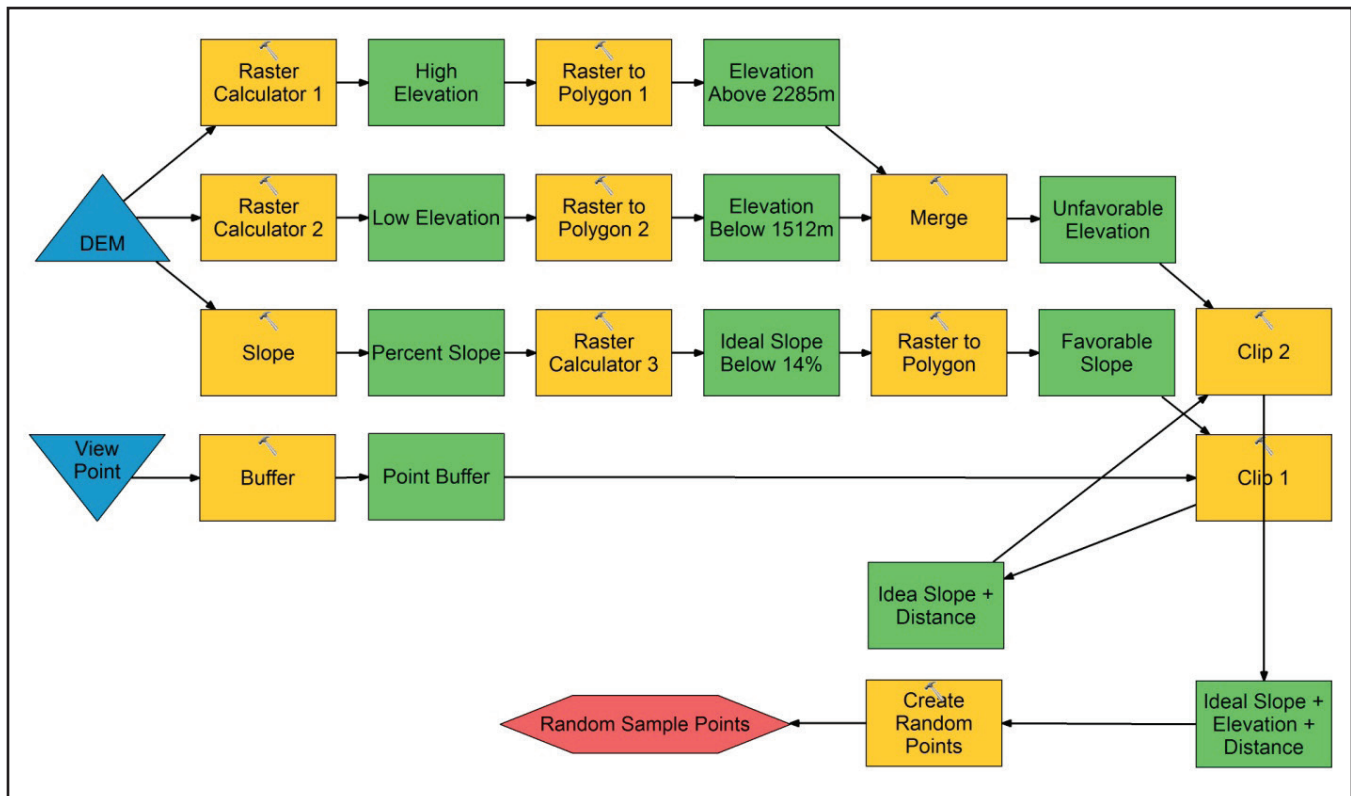


Figure 4. Spatial model of GIS steps for site suitability analysis performed in ArcGIS.

All figures for non-sites were excluded, but the results are similar. The choice of five sample sets is arbitrary. For most analyses two samples would be sufficient, but as evidenced by results of the first dataset where sample 1 was negative and sample 2 positive, claiming that visibility was important for site placement is difficult. The use of multiple samples provides a degree of redundancy coupled with the ability to validate results.

## CUMULATIVE VIEWSHED ANALYSIS RESULTS

As noted in the methods section, the presence of corrugated ware is used as a temporal marker to distinguish sites dating to the Pueblo II and Pueblo III periods. The Pueblo II period spans approximately 150 years (AD 1000-1150) and, in this region, the (early) Pueblo III period spans another 50 years (AD 1150 to abandonment at AD 1200). The actual date of abandonment of the Virgin Branch Ancestral Pueblo region remains a topic of contention among archaeologists as many sites lack absolute dates. The lack of absolute dates, unfortunately, introduces unavoidable bias. In a recent study by Sakai (2014:323-325), six habitation sites (AZ A:12:14[MNA], AZA:12:30[BLM], AZA:12:131[BLM], AZA:12:2014[BLM], AZ A:12:136[ASM], and AZ A:12:71[ASM]) evaluated using radiocarbon and optically stimulated luminescence (OSL) dating techniques produced dates later than AD

1200, suggesting final abandonment of the region likely occurred much later than older existing estimates suggest (Aikens 1966:55; Larson and Michaelsen 1990; Lyneis 1995:235). McFadden (2016:158-159) has recently discussed radiocarbon and other chronological evidence indicating that occupation of the Grand Staircase section of the Virgin Branch region continued after AD 1200 and, possibly, until at least AD 1250. Altschul and Fairley (1989) defined AD 1250 as the possible terminal date for the Virgin Branch region, and Allison (1996) suggests an abandonment date as late as AD 1300. In the absence of absolute dates, the presence of corrugated ware provides the best temporal indication of occupation during the Pueblo II and Pueblo III periods.

## Record Dataset

The record dataset represents a kitchen-sink approach to visibility analysis in which all potential locations are evaluated using both a 10-m and 30-m resolution DEM. The use of 10-m and 30-m resolution DEM data was done for comparison and to validate results.

To assess whether visibility was a significant factor in the decision by prehistoric peoples to construct habitation structures in some areas of the landscape while avoiding other suitable locations a CVA was performed for 320 known sites and five sets of 320 randomly distributed non-sites. If prehistoric peoples constructed habitation structures in areas that would optimize vis-

ibility (i.e., for purposes of communication, resource monitoring, and trade, among other potential factors), known sites will have a larger overall mean value and a higher standard deviation value than the individual sets of randomly selected non-sites. In contrast, if known sites were constructed arbitrarily (without regard to intervisibility), mean and standard deviation values would be relatively similar. Table 1 indicates that known site locations have similar mean and standard deviation values when compared to non-sites. This suggests that

habitations may have been constructed in specific areas for purposes other than intervisibility.

To further test the significance of visibility on site placement, the visibility results for known sites and non-sites were first compared using the Shapiro-Wilks and Anderson-Darling Normality Tests; for comparison, an alpha standard of 0.05 (95% confidence) was utilized.

The reason for choosing an alpha standard of 0.05 is to minimize the potential for type 1 error and to specifically avoid generating false relationships between sam-

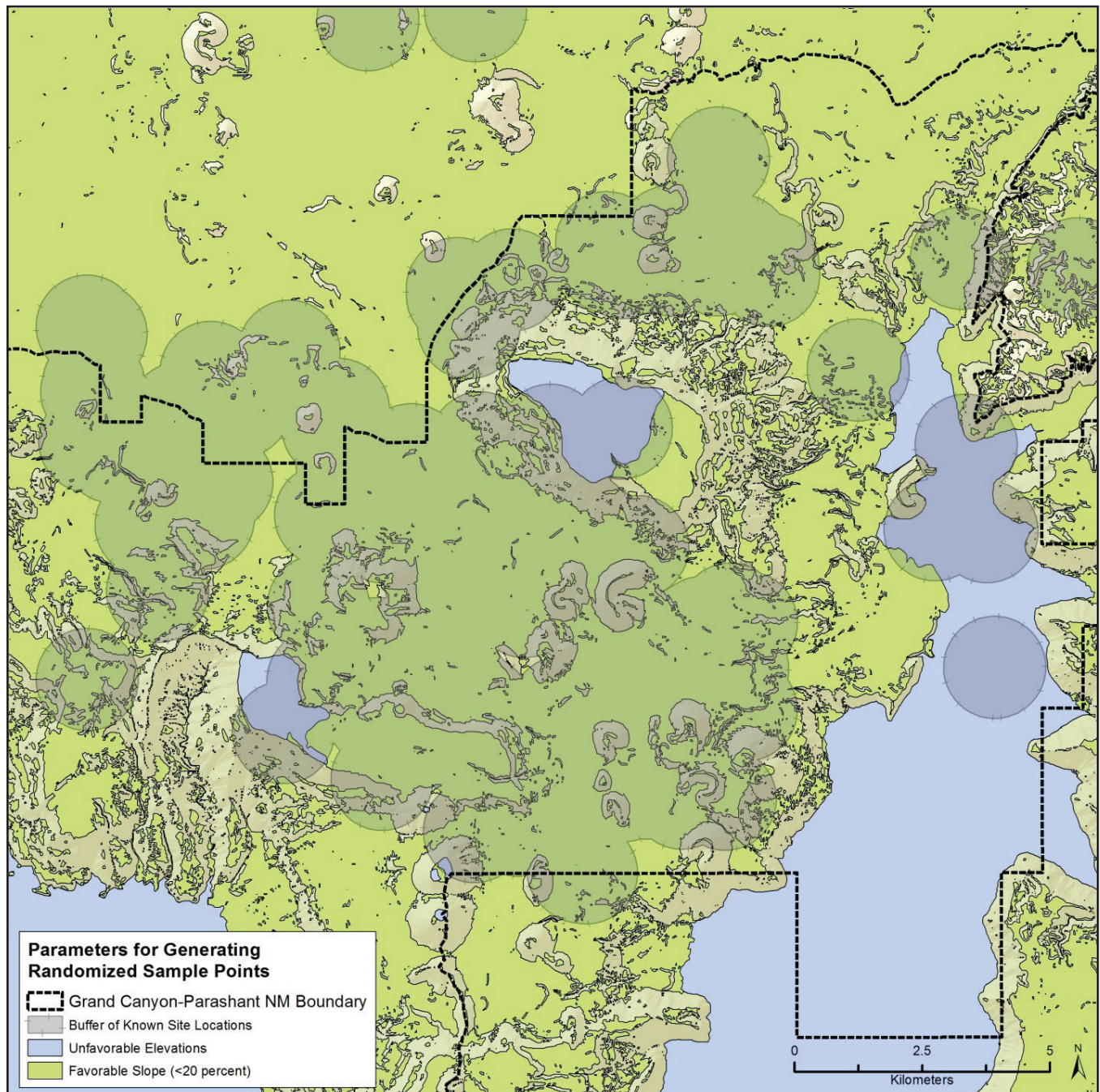


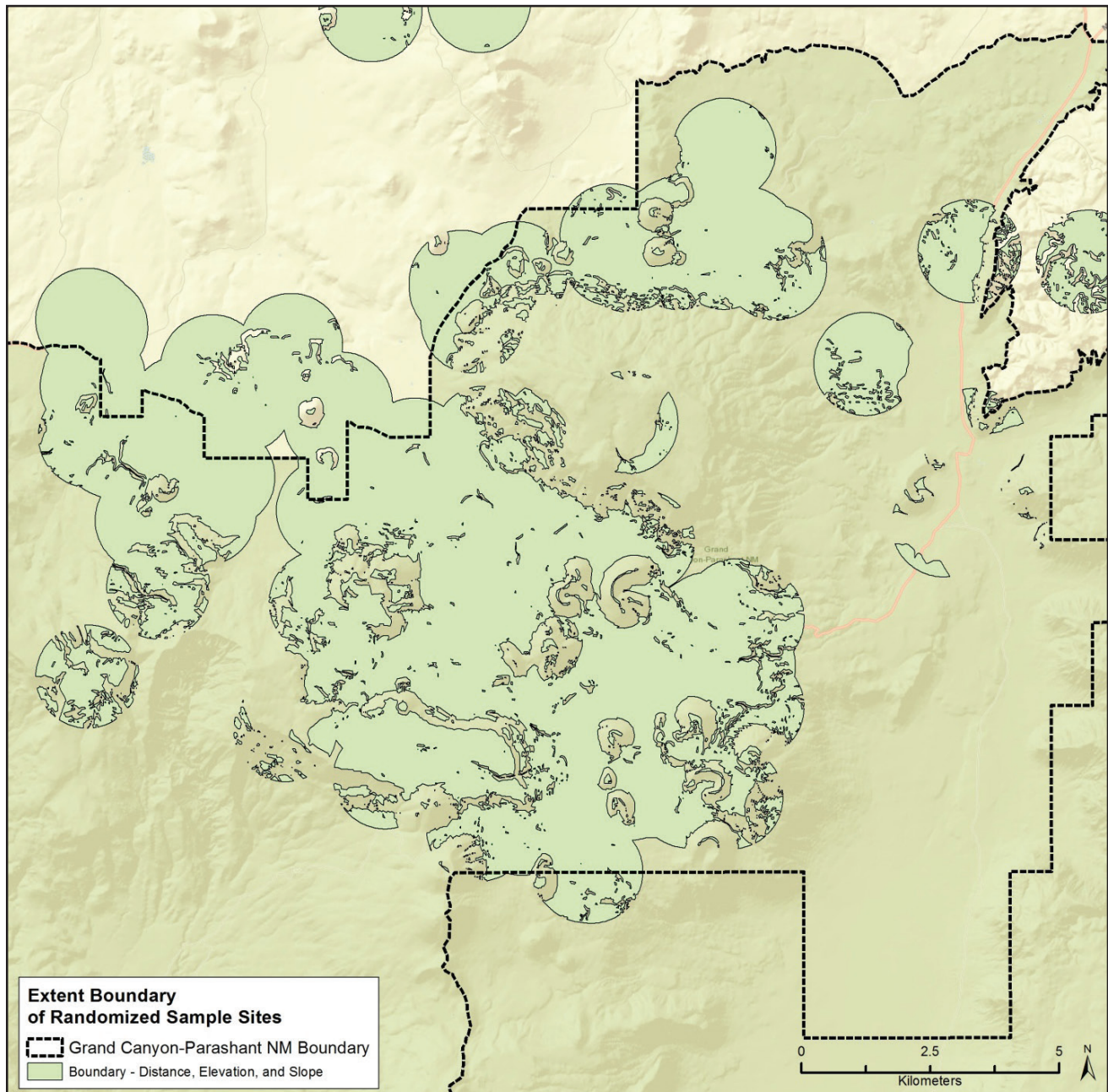
Figure 5. Example of polygon layers used for site suitability analysis: favorable slope, un-favourable elevation, and buffer of known sites.



**Table 1. Statistical data for CVA of 320 known habitation sites and five sets of 320 sample non-sites using a 10-m and 30-m resolution DEM.**

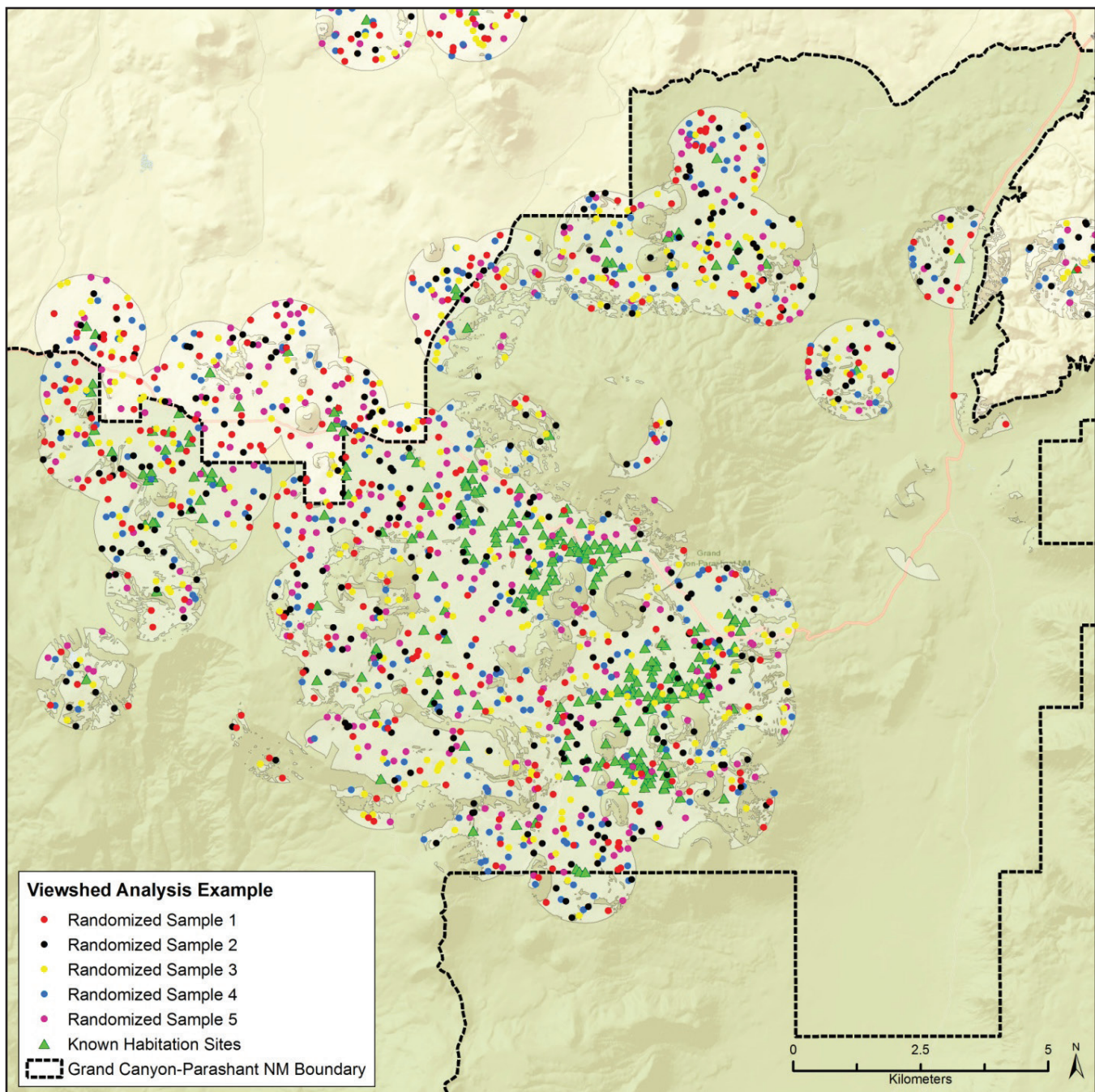
Record Dataset	Maximum number of sites visible 10m DEM	Mean 10m DEM	Standard Deviation 10m DEM	Maximum number of sites visible 30m DEM	Mean 30m DEM	Standard Deviation 30m DEM
Known Sites	80 (25%)	24.16	15.617	80 (25%)	25.02	16.060
Sample 1	80 (25%)	22.54	15.718	83 (25.9%)	22.96	16.149
Sample 2	85 (26.6%)	21.54	14.835	87 (27.2%)	22.26	15.121
Sample 3	77 (24%)	20.82	14.110	79 (24.7%)	21.69	14.488
Sample 4	104 (35.5%)	21.59	16.173	102 (31.2%)	22.44	16.553
Sample 5	83 (25.9%)	22.56	15.937	87 (27.2%)	23.63	16.456

Note: The maximum, and mean values represent the total number of intervisible sites. The minimum values are always one since all sites can view themselves.



**Figure 6. Areas within the boundary layer are within a given distance to known habitation sites, are in areas of less than 14.10 percent slope, and are areas where elevations are neither too high nor too low.**





**Figure 7. Random sample points, limited to areas of similar landscape as known sites for record dataset (n=320). Random sample points were used to determine if a significant difference exists between known habitation sites and randomized non-habitation site locations.**

ple variables that may in reality result from a random distribution. The Shapiro-Wilks and Anderson-Darling tests reject the hypothesis of normality if p-values are less than or equal to 0.05. For both known-sites and non-sites, p-values are  $p < 0.000$  which indicates that data are not normally distributed.

Since the data are not normally distributed, two non-parametric forms of ANOVA were used for analysis, the Kruskal-Wallis test and Mann-Whitney pairwise test. For the 10-m resolution DEM, the Kruskal-Wallis

test found no significant difference between sample medians. Further evaluation using the Mann-Whitney pairwise test (Table 2) indicates that known-sites are significantly different from non-sites for sample 2 (0.026), sample 3 (0.007), and sample 4 (0.012). No significant difference is expected among the sample non-sites because sample sites are randomly distributed. The 30-m resolution DEM produced similar results (Table 3).

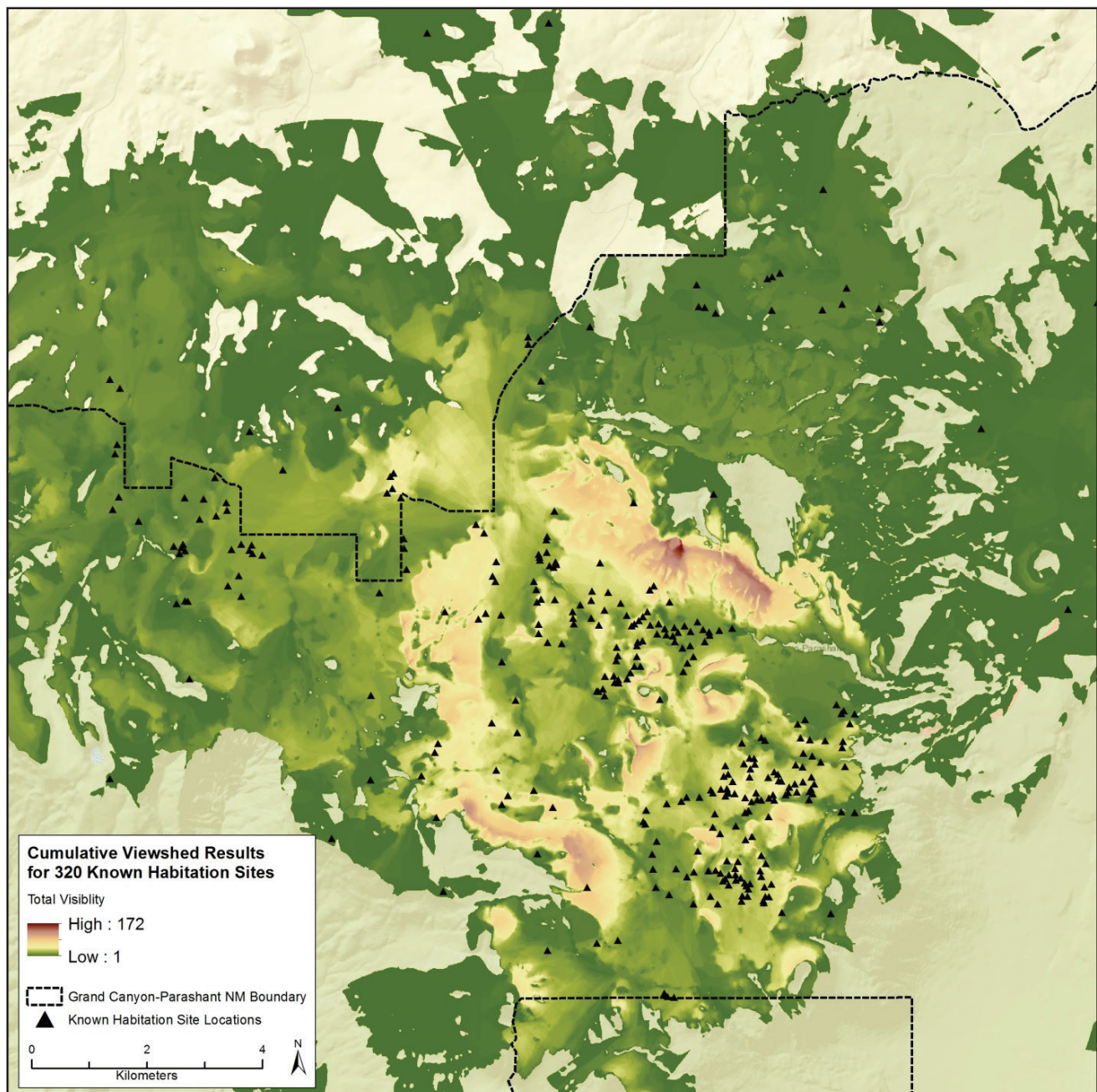
For the 30-m resolution DEM, The Kruskal-Wallis test found no significant difference between sample



**Table 2. Mann-Whitney pairwise significance results for 320 habitation sites and five sets of 320 sample non-sites using a 10-m resolution DEM.**

Dataset	Known Sites	Sample 1	Sample 2	Sample 3	Sample 4	Sample 5
Known Sites		0.121	*0.026	*0.007	*0.012	0.119
Sample 1	0.121		0.509	0.291	0.321	0.907
Sample 2	*0.026	0.509		0.618	0.657	0.545
Sample 3	*0.007	0.291	0.618		0.978	0.340
Sample 4	*0.012	0.321	0.657	0.978		0.367
Sample 5	0.119	0.907	0.545	0.340	0.367	

\* Denotes statistically significant values

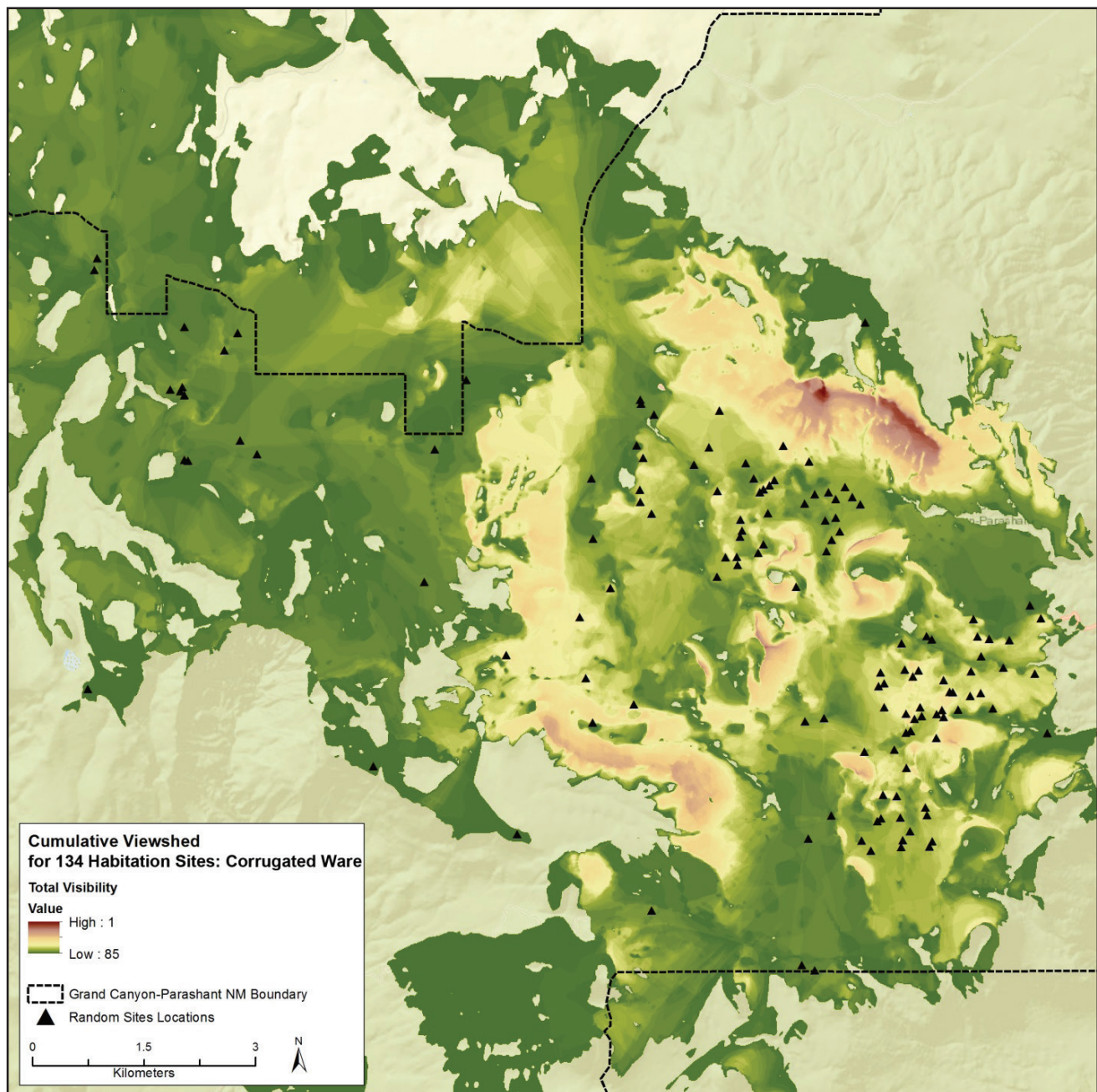


**Figure 8. Areas of high and low visibility based on areas of the landscape visible from 320 known habitation sites. Site locations were derived from original records and viewshed analysis conducted using a 10-m DEM.**

**Table 3. Mann-Whitney pairwise significance results for 320 habitation sites and five sets of 320 sample non-sites using a 30-m resolution DEM.**

Dataset	Known Sites	Sample 1	Sample 2	Sample 3	Sample 4	Sample 5
Known Sites		0.057	*0.025	*0.007	*0.014	0.170
Sample 1	0.057		0.721	0.544	0.572	0.620
Sample 2	*0.025	0.721		0.681	0.730	0.385
Sample 3	*0.007	0.544	0.681		0.954	0.256
Sample 4	*0.014	0.572	0.730	0.954		0.292
Sample 5	0.170	0.620	0.385	0.256	0.292	

\* Denotes statistically significant values



**Figure 9. Areas of high and low visibility based on areas of the landscape visible from 134 habitation sites with corrugated ware. Site locations were derived from original records and viewshed analysis conducted using a 10-m DEM.**



**Table 4. Statistical data for CVA of 134 habitation sites known to contain corrugated ware and five sets of 134 sample non-sites using a 10-m and 30-m resolution DEM.**

Corrugated Dataset	Maximum number of sites visible 10m DEM	Mean 10m DEM	Standard Deviation 10m DEM	Maximum number of sites visible 30m DEM	Mean 30m DEM	Standard Deviation 30m DEM
Corrugated Sites	35 (26.1%)	12.679	7.354	33 (24.6%)	13.007	7.688
Sample 1	54 (40.3%)	9.664	6.921	56 (41.8%)	10.045	7.249
Sample 2	38 (28.4%)	10.425	7.831	37 (27.6%)	10.634	7.861
Sample 3	26 (19.4%)	8.097	5.046	27 (20.1%)	8.493	5.371
Sample 4	33 (24.6%)	9.373	6.285	32 (23.9%)	9.701	6.278
Sample 5	26 (19.4%)	8.201	5.601	27 (20.1%)	8.619	5.999

Note: The maximum, and mean values represent the total number of intervisible sites. The minimum values are always one since all sites can view themselves.

medians. Further evaluation using the Mann-Whitney pairwise test also indicated that known-sites were significantly different from non-sites for sample 2 (0.025), sample 3 (0.007), and sample 4 (0.014). Based on the results from both 10-m and 30-m resolution CVA, there appears to be some difference between known-sites and three of the sets of randomly selected non-sites. A possible explanation for this difference, or rather why a significant difference does not exist between known-sites and all five of the random non-site samples, could be that included sites span multiple periods of occupation. This hypothesis is tested using a second dataset of sites containing corrugated ceramics.

### Corrugated Ceramic Dataset

The corrugated ceramics dataset contains a subset of 134 sites (from the original 320 record dataset) associated with the Pueblo II and Pueblo III periods based on the presence of corrugated ceramic ware. All habitation sites that could be connected to the Pueblo II (AD 1000 – 1150) and early Pueblo III (AD 1150 – 1200) periods of occupation were tested to determine if the views from these sites were meaningful with regards to visibility. In theory, sites dating to this 150 – 200 year interval should contain strong temporal contemporaneity, as opposed to a range of sites dating from Basketmaker II through Pueblo III. To be more specific, 94.81 percent of sites within the corrugated dataset date to the Pueblo II period, only 5.15 percent date to Pueblo II or Pueblo III times, and fewer still, 0.04 percent, date to the Pueblo III period alone.

As discussed previously, if known site locations are significantly different from random non-sites, the number of known sites that can be seen from one another will exhibit higher overall mean and higher standard deviation values than non-sites. If the difference were insignificant, then we would expect to see similar values across samples. Table 4 indicates that known site locations contained overall higher mean and higher standard deviation values than random non-sites. This suggests that known habitation sites may have been constructed

in specific areas for purposes of intervisibility. To examine the visual significance of site placement further, the CVA results for known sites and random non-sites were again compared using the Shapiro-Wilks and Anderson-Darling Normality Tests; for comparison, an alpha standard of 0.05 (95% confidence level) was again utilized. For both known-sites and non-sites, p-values are  $p < 0.000$ , suggesting that the data are not normally distributed. For that reason, the Kruskal-Wallis test and Mann-Whitney pairwise test are again used for analysis. For the 10-m resolution DEM, the Kruskal-Wallis test found no significant difference between sample medians. Further evaluation using the Mann-Whitney pairwise test indicated that known Pueblo II and Pueblo III period sites were significantly different from all random non-sites with all p-values far below 0.000 (Table 5).

The 30-m resolution DEM analysis produced similar results (Table 6), indicating that known-sites were significantly different from all five sets of randomly selected non-sites. Based on the results from both 10-m and 30-m resolution CVA, a clear difference exists between known-site locations and the locations of randomly distributed non-sites. These data suggest that visibility influenced the construction of habitation structures within the Mount Trumbull study area during the Pueblo II through Pueblo III periods of occupation.

## DISCUSSION

The goal of this study was to determine if archaeological habitation structures located in the Mount Trumbull region of northwest Arizona were constructed in specific locations that favored visibility by utilizing CVA. The goal in using CVA has been to understand the spatial relationship between prehistoric habitation structures. My primary hypotheses were: (I) Virgin Branch Ancestral Pueblo habitation sites were constructed in areas of the landscape that favor overall intervisibility, and (II) If analysis is limited to habitations that contain corrugated ceramic ware, a significant statistical difference should exist providing confirmation of the primary hypothesis.

**Table 5. Mann-Whitney pairwise significance results for 134 habitation sites known to contain corrugated ware and five sets of 134 sample non-sites using a 10-m resolution DEM.**

Dataset	Corrugated	Sample 1	Sample 2	Sample 3	Sample 4	Sample 5
Corrugated		*0.0004	*1.70E-07	*1.09E-07	*1.48E-07	*2.01E-07
Sample 1	*0.0004		0.1216	0.0744	0.0845	0.0607
Sample 2	*1.70E-07	0.1216		0.8053	0.7346	0.6059
Sample 3	*1.09E-07	0.0744	0.8053		0.8938	0.6777
Sample 4	*1.48E-07	0.0845	0.7346	0.8938		0.9013
Sample 5	*2.01E-07	0.0607	0.6059	0.6777	0.9013	

\* Denotes statistically significant values

**Table 6. Mann-Whitney pairwise significance results for 134 habitation sites known to contain corrugated ware and five sets of 134 sample non-sites using a 30-m resolution DEM.**

Dataset	Corrugated	Sample 1	Sample 2	Sample 3	Sample 4	Sample 5
Corrugated		*0.0008	*1.75E-07	*4.53E-07	*1.16E-06	*1.86E-06
Sample 1	*0.0008		0.0804	0.0972	0.1086	0.0730
Sample 2	*1.75E-07	0.0804		0.8951	0.9609	0.8200
Sample 3	*4.53E-07	0.0972	0.8951		0.9270	0.7187
Sample 4	*1.16E-06	0.1086	0.9609	0.9270		0.8688
Sample 5	*1.86E-06	0.0730	0.8200	0.7187	0.8688	

\* Denotes statistically significant values

Hypothesis I holds that prehistoric settlements were constructed in specific locations across the landscape to favor intervisibility for some utilitarian purpose. Based on analytical results from the CVA, this hypothesis can be accepted. The first CVA results for 320 known sites (see Tables 2 and 3) indicate that, despite some interference, known site locations exhibit a significant difference in values compared to random non-site locations. This trend strengthens if we examine results of the CVA limited to sites that theoretically were occupied only during the Pueblo II to Pueblo III periods. Here there is a significant difference between known site location values and all random non-site values (see Tables 5 and 6). The p-values for random non-sites range from a maximum of 0.927 to a minimum of 0.061, which, although insignificant, are above the alpha standard of 0.050. In contrast, p-values for the locations of known-sites are significantly smaller, with all p-values far below 0.000 when known site locations are compared to random non-sites locations. Based on the CVA results, prehistoric settlements occupied during the Pueblo II and Pueblo III periods appear to have favored intervisibility.

Hypothesis II posits that, if the analysis is limited to habitations that contain corrugated ceramic ware, a significant statistical difference should exist. Hypothesis II is accepted based on results from the corrugated dataset. The corrugated dataset represents a 150-200 year interval. The results indicated that all sample non-sites were significantly different from known site locations,

so much so, that all values are expressed using scientific notation. The results demonstrate that prehistoric habitation sites built by the Virgin Branch Ancestral Pueblo peoples were constructed in specific areas of the landscape that favored intervisibility and did not result from random unplanned construction.

## CONCLUSION

The goal of this study was to determine if Virgin Branch Ancestral Pueblo habitation sites in the Mount Trumbull region were constructed in areas of the landscape that favored intervisibility. Based on results from several cumulative viewshed analyses examining a set of prehistoric habitation sites linked to the Pueblo II and Pueblo III periods, a clear difference was shown to exist between known site locations and the locations of randomly distributed sample non-sites. The data suggest that intervisibility influenced the construction of habitation structures within the Mount Trumbull study area during the Pueblo II and Pueblo III periods. At present no current research except for Richards-Rissetto's (2010) Maya study has utilized site suitability analysis to limit randomly generated points to locations that are similar to known archaeological sites. The research presented in this study addresses this deficiency by comparing known archaeological site locations to five sets of randomly distributed sample non-sites limited to areas of similar terrain producing a refined representation of visual significance. One of the primary draw-

backs within the Mount Trumbull study area is a shortage of radiocarbon dates that could be used to furnish a stronger temporal framework for assessing contemporaneity. Such a framework would contribute further to our understanding of site intervisibility in this locality. It is anticipated that future research will incorporate more radiocarbon and OSL dating to provide a better understanding of the prehistoric world inhabited by the Virgin Branch Ancestral Pueblo peoples.

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# LATE ARCHAIC AND EARLY FORMATIVE ARCHITECTURE IN THE SALT RIVER VALLEY, ARIZONA

Mark R. Hackbarth

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*Recent excavations of Late Archaic and Early Formative components found in the Salt River Valley provide insight into early architecture styles, chronology of absolute dated structures, and the camps, limited activities, farmsteads, hamlets, and other settlement types of central Arizona. This study of architectural variables applies ethnographic insights to structure's size, shape, and the number and formality of internal features to explore site and settlement patterns. Comparison of seven architectural variables from sites in upland and riverine settings dating from the San Pedro through Vahki phases (excluding Early Cienega) shows variability that likely represents settlement intensification and increasing social complexity after AD 400. The number of dated features, however, is relatively small compared to the number of houses that were constructed and used in the past and this incomplete record may skew what is seen as the most common house elements. The lack of dated Late Cienega phase houses and the preponderance of circular structures into later phases is symptomatic of a small sample.*

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Archaeologists and the public alike tend to gravitate towards highly visible architectural features and sites (e.g. Casa Grande Ruins, Mesa Verde, Chaco Canyon) and their above-ground architecture of platform mounds, big houses, and masonry cliff dwellings to explain and theorize about culture contact, wayward migrants, and a variety of other topics. In the early twentieth century archaeologists began to appreciate that more mundane domestic architecture could inform about the past (Woodward 1933). Over the last 90 years archaeologists have examined public and domestic architecture patterns to explore topics such as habitation site's plan and organization, social structure, ceramic horizons, origin of villages, and cultural development (Cable and Doyel 1987; Cable et al. 1985; Doyel 1991; Howard 1985; Lindeman 2003; Lindeman and Wallace 2004; Mabry 2000; Wallace and Lindeman 2012; Wilcox and Sternberg 1983; Wilcox and Shenk 1977; Wilcox et

al. 1981). In this study, a sample of excavated and dated architectural features is used to explore diachronic trends in domestic architectural features for the San Pedro (1200–800 BC), Late Cienega (400 BC–AD 1/50), Red Mountain (AD 1–450) and Vahki phases (AD 450–700) (dated features from the Early Cienega [800–400 BC] did not have the necessary preservation to be included in this study). Features with reliable dates provide detail about the most common architectural traits. Nonparametric statistics (median and mode) identify the variables that appear most frequently in structures to infer a narrative of cultural development through time.

Other examinations of Late Archaic and Early Formative architecture have used similar data sets and provide well-reasoned explanations of the past (Cable and Doyel 1987; Gregory and Diehl 2002; Lindeman 2003; Mabry 1998, 2000; Wallace and Lindeman 2012). My goal is to identify the most common form of well-dated domestic architecture in central Arizona. Focusing on a limited geographical area assists in parsing the most common feature characteristics and site types for each time period; this limitation of scope “simplifies the equation” (after Krauss 2007) and facilitates recognition of prime variables. Circumscribing the study to a limited area lessens the chance that aggregated data includes—unbeknownst to the archaeologist—culturally distinct groups, or at least, a group that was beginning to differentiate and limits the potential that environmental variables could influence the data. Evaluating the sites and features used in this study raises questions about the representativeness of the currently available anecdotal excavation information. Data in this study was obtained from multiple excavation projects that may have biases stemming from limited project funds, investigator interests, or other factors. Future investigators may want to consider how to close the data gaps identified in this study.

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The phases in this study are transitional from hunter/gatherers (foragers) to farmers (or farmagers as Diehl and Davis [2016:338] refers to them), which creates dissonance when the terms and definitions of house forms and site types created for fully sedentary populations are applied. Descriptive terminology developed for agricultural societies has implications about site-size hierarchies, unexpressed meanings of population density, land tenure, social organization, and other traits (Flannery 1972a). Application of terms for sedentary agriculturalists to precursor groups that were just starting to adopt agriculture, moved frequently, and had a different social structure is fraught with potential errors. Similarly, mobile Archaic hunter-gatherers camps are extremely variable in terms of residency, social structure, duration, and complexity within given environmental settings (Hamilton et al. 2018) and cannot be readily applied to later populations.

## STUDY AREA AND DEFINITIONS

This study's parameters are purposefully limited to sites located in central Arizona, mainly within an imaginary 50-mile long rectangle roughly parallel to the Salt River Valley from Queen Creek on the east to the Agua Fria River on the west (Figure 1). This limited geographical area was selected despite the pan regional character of Southwest societies two to three millennia ago (Doyel 1991; Feinman 1991; Gumerman 1991; LeBlanc 1982; Whittlesey 1995; Wilcox 1988). Sites within this geographical area were not included if their houses lacked absolute dates or had fragmentary structures (e.g. AZ T:12:159[ASM]/La Villa or AZ T:12:95[ASM] and AZ T:12:96[ASM]). Readers interested in a larger geographical area should examine Wallace and Lindeman (2012).

Seventy architectural features from nine sites in nine project areas provide information for this meta-analysis (Appendix A). Pithouses were selected for inclusion in this study if they were sufficiently preserved to distinguish floor shapes as circular, oval, bean, irregular, or rectilinear (square, rectangular, subsquare, and subrectangular) forms. Features were included if they had reliable standard radiocarbon, AMS dates, or direct stratigraphic evidence indicating their age. Unless otherwise noted, the chronometric samples used in the analysis are AMS calibrated 2-sigma date ranges, in a few cases pooled data from standard radiocarbon samples are provided, or stratigraphic information is used to date a house. The dated house features were grouped by archaeological phases (Table 1) before quantitative and quantitative data was summarized for floor size, number of hearths, number of postholes, number of pits, and floor shape, presence/absence of an entrance, and floor preparation. If identifiable, the shape of a projecting entrance was tabulated. Intramural features and exterior architectural attributes were summarized

**Table 1. Dated structures from upland and riverine settings included in this study.**

Phase	Upland	Riverine
San Pedro (1200–800 BC)	9	0
Early Cienega (800–400 BC)	0	0
Late Cienega (400 BC to AD 1)	1	9
Red Mountain (AD 1–450)	4	30
Vahki (AD 450–700) <sup>a</sup>	4	13

<sup>a</sup> Following Craig (2001:141) the former Estrella and Sweetwater phases of the Pioneer period have been subsumed under the Vahki phase.

for each phase to identify what was the most common variable for prepared/unprepared floors, the number of hearths, subfloor pits, and postholes. The structure's exterior variables include the size, floor plan (shape) of the house, and whether a protruding entry was present.

Site types in this study fall along a continuum from small to large whereby camps and limited activity sites are locations where entire social groups or subsets of the entire group labored to collect and process resources. Farmsteads may have included one or two nuclear families or an extended family that lacked a hierarchy beyond the family (see Ward 1978 for examples). Hamlets are composed of one corporate entity encompassing a few households that may have had lineage leaders, but not corporate group leaders. Reference is made to villages (a maintained aggregate and conglomeration of multiple corporate entities with residential permanence) but has the least applicability to the Late Archaic sites considered in this paper and only slightly more relevance to the Early Formative sites. Fully formed villages with plazas were entities that only started to come into being during the late Pioneer period. Settlements dating to the Red Mountain and Vahki phases do not conform to village compositions and patterns that were common later in the Hohokam sequence.

As with site types, defining a settlement pattern for the transitional period of populations that coalesced and evolved into farmagers is fraught, particularly during the Red Mountain phase when settlements appear as persistently impermanent locations with intermittent (seasonal) occupations (after Wallace 2003). Experimentation and emulation with architectural forms and settlement strategies occurred during periods of transition and we can expect that an unknown number of the sites and houses that archaeologists have examined are from people that did not influence or contribute to later cultural developments—failure was an option during the cultural experiment that farmagers initiated. Catastrophic loss of domestic crops without backup resources or a nearby population that could be relied upon for temporary assistance over consecutive years could have resulted in fragmentation, and reforming of the group, migration, or its extinction. There is no way



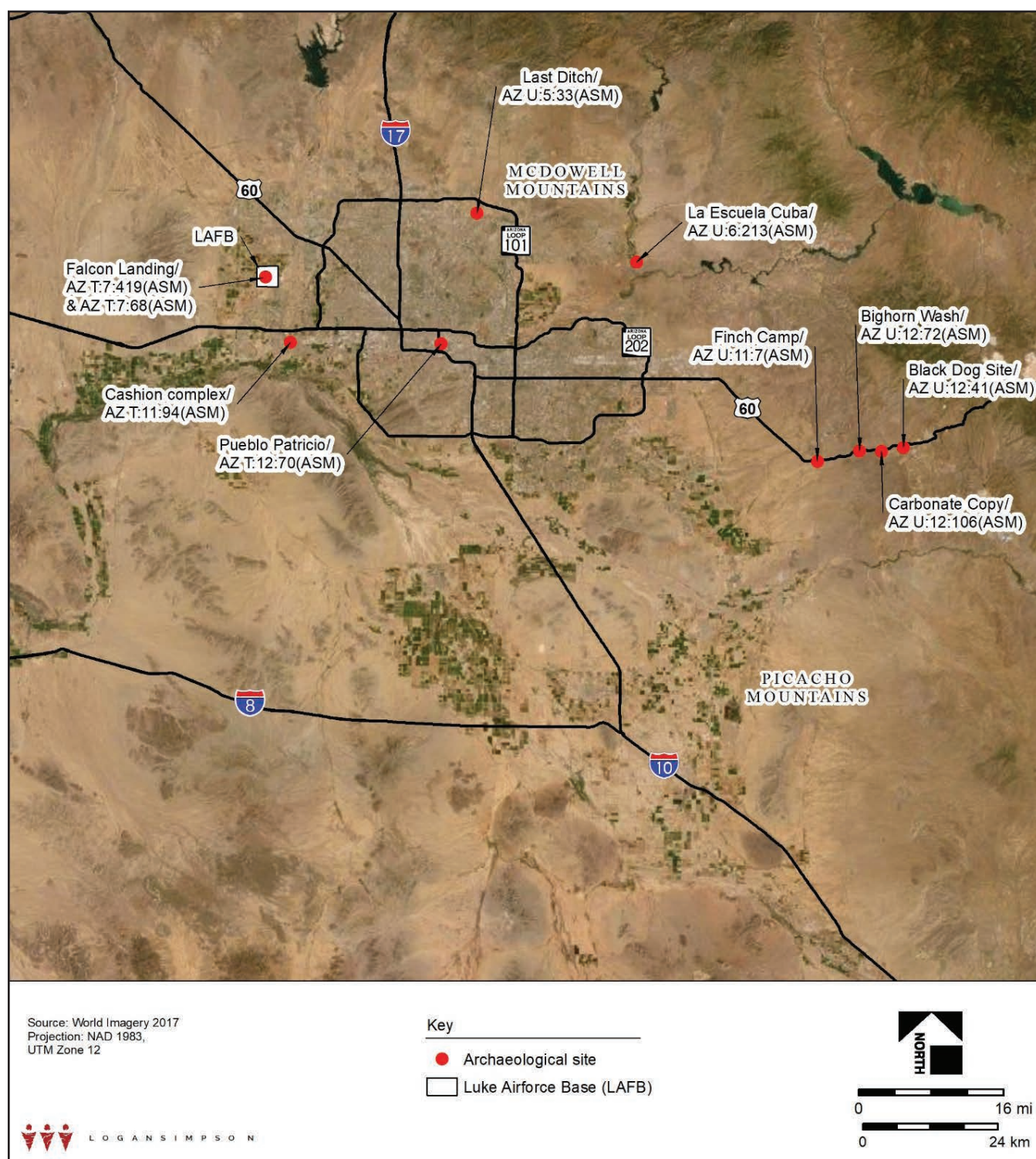


Figure 1. Projects and sites discussed in this paper.

to identify these “dead ends” in the sample of architectural remains or whether they comprise a few, many, or none of the houses in the study.

This issue of architectural “dead ends” brings up the twin questions of sample size and completeness of data. The current sample of dated and excavated houses ( $n=70$ ) represents anecdotal evidence of structural forms

that is adequate to investigate questions of architectural variability through time. The chronometric evidence is unimpeachable, but there is potential for errors in assigning structures to one phase or another where absolute dates overlap archaeological phase boundaries. Whether it is appropriate to extend the meta-analysis data into the higher-level realm of modeling human behavior depends

on the completeness of the archaeological record. A brief review of sites and excavations in the following section examines site function (as determined in the excavation report) and the extensive excavations to establish whether future excavations could reveal data that would contradict the observations used in this study. This review of excavations assumes the surface artifacts define the limits of subsurface materials, an unlikely proposition. For example, the site boundary of AZ U:5:33(ASM)/Last Ditch was identified on the basis of surface materials dating to the Hohokam, but the majority of subsurface features date to the Archaic and have no relationship to surface materials. Nevertheless, to facilitate comparisons between sites the amount of excavation (meters square) is expressed as a percentage of the site's extent.

The study area is divided into sites on bajada margins (upland setting) and sites near flowing water (riverine setting) (Table 2). At riverine sites the most common feature classes (habitation structures) and site activities (variety of extramural pits including burials) unite them as a group, even though the distance to water and size of the waterway varies. Two locations provide most of the data for the riverine setting: four sites in the US 60 project area (Wegener and Ciolek-Torrello 2011) and six project areas in AZ T:12:70(ASM)/Pueblo Patricio (Cable et al. 1985; Cable et al. 1982, 1984; Hackbarth 2010, 2012; Henderson 1995). The US 60 sites are the farthest from a water source and are relatively close to upland landforms (Superstition Mountains). Pueblo Patricio is close to a large desert stream but is relatively distant from small mountain ranges (Phoenix, South, and McDowell mountains).

Camps or limited activity sites in the uplands are united by the presence of numerous extramural pits used to process native plant resources. Two Archaic sites in the Luke Air Force Base (LAFB) project area are near

the west side of the study area and contribute most of the information about early camps (Hall and Wegener 2017). These two sites are situated on the lower bajada of the White Tank Mountains where subsurface salt domes created a perched water table that supported a diverse plant community. Over 3,000 prehistoric pit features and rock and ash clusters at the LAFB sites demonstrate intensive processing of resources. At the north end of the study area are three sites near the McDowell Mountains with architectural structures and more than 590 prehistoric thermal pit features and rock and ash clusters at the distal end of the Rawhide Wash Alluvial fan. Surface water descending the Rawhide Wash Alluvial fan created an environmental zone that attracted foragers to seasonally available resources (Albush et al. 2008; Hackbarth 1998; Kirvan et al. 2008; Phillips et al. 2001; Rogge 2011, 2015).

Ethnographic data aids in the interpretation of architectural characteristics used in this study. Researchers have identified correlations between architectural variables with a group's worldview (Whiting and Ayres 1968), control and management of arable agricultural fields (Flannery 1972b), and restriction of shared resources (Wills 1992; Flannery 2002). Mobile populations tend to create temporary habitation structures that are round or oval (Whiting and Ayres 1968). Explanations for preference of round structures range from the esoteric idea of mimicking the open view shed encountered by forager populations to the pragmatic fact that circular structures require less construction materials than other shapes, they encompass the maximum amount of space with the same amount of construction materials, and round, dome-shaped roofs create intersecting arches that are stronger than flat roofs with angular construction methods.

**Table 2. Sites and numbers of features included in this study.**

Site	Structures <sup>a</sup>	Setting	Reference
AZ T:7:68(ASM)	1	Upland, 5 km from Agua Fria River	Hall and Wegener 2017
AZ T:7:419(ASM)/ Falcon Landing	16	Upland, 5 km from Agua Fria River	Hall and Wegener 2017
AZ T:12:70(ASM)/ Pueblo Patricio	1	Riverine, 2 km from the Salt River	Cable et al. 1982
AZ T:12:70(ASM)/ Pueblo Patricio	5	Riverine, 2 km from the Salt River	Cable et al. 1985
AZ T:12:70(ASM)/ Pueblo Patricio	4	Riverine, 2 km from the Salt River	Henderson 1995
AZ T:12:70(ASM)/ Pueblo Patricio	8	Riverine, 2 km from the Salt River	Hackbarth 2010
AZ T:12:70(ASM)/ Pueblo Patricio	4	Riverine, 2 km from the Salt River	Hackbarth 2012
AZ U:5:33(ASM)/ Last Ditch	1	Upland, 11 km from Cave Creek	Hackbarth 1998
AZ U:6:213(ASM)/ La Escuela Cuba	3	Riverine, 1 km from the Verde River	Hackbarth 1992
AZ U:11:7(ASM)/ Finch Camp	20	Riverine, 2.5 km from Queen Creek	Wegener and Ciolek-Torrello 2011
AZ U:12:41(ASM)/ Black Dog	1	Riverine, 2.5 km from Queen Creek	Wegener and Ciolek-Torrello 2011
AZ U:12:72(ASM)/ Bighorn Wash	5	Riverine, 2.5 km from Queen Creek	Wegener and Ciolek-Torrello 2011
AZ U:12:106(ASM)/ Carbonate Copy	1	Riverine, 2.5 km from Queen Creek	Wegener and Ciolek-Torrello 2011

<sup>a</sup> Number of dated structures used in this paper only, more features are present in the reports.



Flannery (1972b) commented that societies with rectilinear structures also tend to create rectilinear agricultural fields. He notes that rectilinear agricultural fields are the optimal way to equitably share highly productive agricultural lands by creating adjoining fields that leave little or no space between each plot. Land used for production of food is a highly valued commodity and closely packed fields allow the maximum number of people to share in the best productive soils and share water resources that irrigate abutting and closely fitted fields. If agricultural fields were circular, the abutting margins of fields would touch at only a few places and large tracts of unused land would develop between fields, an inefficient use of arable land. Rectilinear agricultural fields maximize the number of people with access to arable land and probably developed contemporaneously with restrictive land tenure systems whereby outright land ownership or a right to use plots of land remains within the same group (Wills 1992; Flannery 2002). Constant monitoring and maintenance of the boundary between closely spaced agricultural fields is needed to restrict access and prevent encroachment from adjoining land users.

Maintaining land ownership or a right to use land often involves creation of boundaries and physical barriers to prevent incursions. Fences and cairns are easily constructed elements that serve as field markers to define the limits of agricultural fields. However, fences and cairns are small and easily moved, modified or destroyed. Architecture established in or near fields serves as a substantial and highly visible marker on the landscape that reifies land-use rights though its mere existence (Greenwald 1993). Architectural structures have an obvious advantage over fences or cairns as claim markers in terms of their greater bulk and size. Architectural features used as land tenure markers have the added advantage of providing living space for people that enforce the exclusion of others. Importantly, the size of the structure also signals the wealth and status of households that claim the land (Craig 2001). The ability to harness labor and materials to construct a large, imposing, and substantial architectural feature can serve as a warning against encroachment, even if not occupied.

The size and shape of architectural features signals a building's purpose and the intended length of use (Kent 1991; Kent and Vierich 1989). Small structures with few elaborations are typically less permanent than large structures built with multiple postholes, hearths, wall trenches and intramural pits. Construction of a substantial structure using durable materials signals the intent to use a feature or site for a long period of time, whereas small structures are built for brief periods of use. The use of more materials and labor-intensive construction efforts are investments in permanency that can mark a group's territory.

Characteristics of structures visible from outside of the structure (house size, shape, entry, and wall composition) are routinely used to classify feature function and

temporal association (Ciolek-Torrello and Greenwald 1988; Hackbarth 2010; Henderson 1995; Lindeman 2003; Wallace and Lindeman 2012). Intramural variables (formal/informal construction of floor and wall, hearths, subfloor pits, and postholes/bench posts) have been used to summarize feature function (Motsinger 1994). Intramural pits are particularly informative about site activities because they may be used for the storage of goods and restricting visibility of goods. Flannery (2002) and Wills (1992) suggest that intramural storage pits (as opposed to extramural storage pits) are a strategy to minimize resource sharing among members of a group. Resources that are stored inside of houses are not visible to other group members, which may reduce the chance that persons outside of a structure would request a share of stored resources. Intramural pits in small storage structures may serve as repositories or a cache of valuables that are intended to be recovered after an absence from the site. In combination, these variables are used in this paper to examine the evolution of architectural features during the change from mobile foragers to fully sedentary farmers in central Arizona.

Problems related to meta-analyses stem from combining feature descriptions and chronometric data from project reports that used different excavation strategies and descriptive methods. While coding the architectural variables I used a liberal perspective for some variables, (e.g. the presence of any amount of plaster on the floor was used to score the structure as having a prepared surface). Other variables were coded with a more conservative approach (e.g., hearths had to have evidence of heating in a depression, not just small patches of burning on a level floor near an entrance). I accepted the pithouse sizes provided in the excavation reports.

## SETTLEMENT DATA

Features used in this presentation (Appendix A) span the period from agriculture's increasing importance to just before the AD 700 florescence of the Hohokam with its large population and complex social organization. The Late Archaic comprising the San Pedro (1200–800 BC) and Late Cienega phases (400 BC to AD 1/50) has the earliest features included in the study; the Early Cienega phase (800–400 BC) is not represented for lack of well-preserved dated houses. The Early Formative is composed of the Red Mountain (AD 1–450) and Vahki (AD 450–700) phases. A complex social organization including large villages is present in the study area after AD 500 (Schlanger and Craig 2012) or more broadly AD 400–700 (Sinensky and Farahani 2018:283). Late Archaic lifestyles and residential structures included round, stick-frames structures, temporally diagnostic bifaces, along with maize and beans grown in irrigated fields (Diehl and Davis 2016; Huckell 1998). Diehl (1992) suggests these lightly built houses in the Santa Cruz River Valley were used for up to four months of the year;



similar durations can be expected in the Salt River Valley. Later occupations tend to have rectilinear structures occupied for the entire year.

Transition from Late Archaic to more sedentary lifestyles may explain the change in house shapes, but the change is not expected to have been universal or immediate. Change may have occurred at different times and tempos among people in the region. Some groups may have replaced seasonal transhumance between upland and riverine settings more or less rapidly than others (Roth 1992; Halbirt and Henderson 1993) and their success or failure may have contributed to splintering or remodeling of groups (Hamilton et al. 2018). Variability in architectural forms may have occurred if some individuals or subgroups maintained a traditional lifestyle including moving between environmental zones, while other groups placed more emphasis on emerging opportunities for agricultural pursuits near waterways. Unequal adoption of agriculture may have benefitted both traditionalists and experimenting groups by buffering each other against failure of agricultural production or foraging. The adoption of new settlement patterns and architectural forms recognized in this exploratory study could reflect temporal or functional differences in society, individual preferences or habits, stochastic variability, or biases in meta-analyses' sample selection for this transitional time period.

Too few houses dating to the earliest time periods in the Salt River Valley are available for comparative purposes. Three sites have the earliest remains: Cashion Complex, AZ T:11:94(ASM) (Miljour et al. 2009), AZ U:5:33(ASM)/Last Ditch (Phillips et al. 2001), and AZ T:7:419(ASM)/Falcon Landing (Hall and Wegener 2017). The Cashion Complex is near the confluence of the Gila and Agua Fria rivers and has two Early Archaic structures. The houses have circular to oval floor shapes that measure approximately 3 m in diameter, or approximately 7.1 m<sup>2</sup> in size (Graves et al. 2011). These pithouses date to 5210–4940 Cal. BC or 4540–4400 BC (Feature 80) and 5040–4800 Cal. BC, 5000–4840 Cal. BC, and 4960–4720 Cal. BC (Feature 42) (Miljour et al. 2009:Table 6) and are in the vicinity of what would have been an extensive mesquite bosque with substantial food and fuel resources. At AZ U:5:33(ASM)/Last Ditch two houses are in an upland setting and have oval outlines that measure 2.04 m by 1.43 m (2.27 m<sup>2</sup>; Feature 173) and 2.36 by 2.10 m (3.89 m<sup>2</sup>; Feature 227). These two indirectly dated Middle Archaic houses are in a stratum dated to 2130–1900 BC (Phillips et al. 2001:33). Eleven structures broadly dating to the Archaic are known from the upland LAFB project area and tend to have circular or oval plan views or else indeterminate shapes and sizes. One exceptionally large circular structure (Feature 2602 at AZ T:7:419(ASM)/Falcon Landing) contradicts this pattern of small structures and is 32.34 m<sup>2</sup> in size (Hall and Wegener 2017:86, 90–100). These early structures have some similarities with later time periods that are

noteworthy, specifically circular or oval floor shapes and small sizes, most often ranging from 2.25 m<sup>2</sup> to 6.26 m<sup>2</sup> (Hall and Wegener 2017:111–126).

The earliest architectural evidence used in this study comes from upland sites on the western edge of the Agua Fria River basin. The largest site in the LAFB project area is AZ T:7:419(ASM)/Falcon Landing which has 52 structures from multiple time periods (16 were used in this study), 2,738 pit features, plus other feature classes dating to the Middle Archaic through historic periods (Hall and Wegener 2017:318). One smaller LAFB site (AZ T:7:68[ASM]) contributes one dated architectural feature to this study from 1.4 acres (5,782 m<sup>2</sup>) of stripping. Extensive mechanical stripping at AZ T:7:419(ASM)/Falcon Landing exposed 43.6 acres (176,326 m<sup>2</sup>) to an average depth of 40 cm; all architectural features were excavated (52 pithouses at AZ T:7:419[ASM]/Falcon Landing), 59% of the 2,738 extramural pits (n=1,638), and 100% of human remains (n=2) (Hall and Wegener 2017:79). The potential for additional excavation to alter our perspective of both site's function, age, and composition is essentially nil. The materials represent temporary habitation at a Middle Archaic through historic period resource processing site.

At the northern edge of the Salt River Valley are three adjacent sites, AZ U:5:33(ASM)/Last Ditch (202 acres), AZ U:5:94(ASM) (25.2 acres), and AZ U:5:95(ASM) (28.4 acres) with a combined 532 features of all kinds (mainly pits and ash/rock clusters), but only one directly dated architectural feature that was included in this study. The three sites' original boundaries were based on surface artifacts which have minimal relationship to the distribution of subsurface features. Extensive mechanical trenching and stripping have explored a combined 42.2 acres of the three sites (Albush et al. 2008; Hackbarth 1998, 2019a; Kirvan et al. 2008; Phillips et al. 2001; Rogge 2011, 2015; Rogge and Kirvan 2017). Although less than 19% of all three sites have been stripped, large portions of the three sites have been tested and lack any features; only a few areas are expected to have additional subsurface features. The potential that newly discovered and excavated materials could change the perspective of each site's function, age, and composition is low to moderate. Based on the materials recovered so far, the three sites represent temporary habitation at a Middle Archaic through Sedentary period resource processing loci, with the Formative components mainly used as agricultural farmsteads.

Upland architecture dating to the Red Mountain and Vahki phases was found at AZ U:5:33(ASM)/Last Ditch (Hackbarth 1998) and AZ T:7:419(ASM)/Falcon Landing (Hall and Wegener 2017), but numbered only four features. Riverine sites used during the Red Mountain and Vahki phases account for 47 pithouses in this study. Twenty-two houses used in this study are from AZ T:12:70(ASM)/Pueblo Patricio, which has been the subject of more than six excavation projects. Architecture

at AZ T:12:70(ASM)/Pueblo Patricio is from multiple components that range from the Red Mountain phase (Hackbarth 2010, 2012, 2019b; Henderson 1995; Montero and Hackbarth 1992) to Classic period (Cable et al. 1982). The earliest structures are small, short-term, seasonally occupied pithouses with few artifacts or extramural features. The Block 24-East project area is unlike the rest of the site and has several houses dating to the Pioneer period (Cable et al. 1985). Cable and Doyel (1987) described Block 24-East as a village but Henderson (1995) has characterized the rest of the settlement at AZ T:12:70(ASM)/Pueblo Patricio as a farmstead. Architectural remains are split between substantial structures (Cable et al. 1982, 1985; Hackbarth 2010, 2012; Henderson 1995) and lightly built field houses (Cable et al. 1984; Hackbarth 2010; Montero and Hackbarth 1992; Sorrell 2008). Typically, the houses were isolated structures or a small group of pithouses that were used during repeated visits to locations adjoining arable land (Cable et al. 1985; Hackbarth 2010, 2012, 2019b; Henderson 1995).

The extensive investigations in downtown Phoenix have exposed portions of AZ T:12:70(ASM)/Pueblo Patricio over four decades with an unknown amount of the site remaining in untested locations or under streets and sidewalks. However, excavations have now investigated nearly 50% of the original site boundary. What we can say about AZ T:12:70(ASM)/Pueblo Patricio is that it does not conform to a single site "type" and the potential that new excavations will change our perspective of the site's function, age, and composition is moderate to high. Based on the materials recovered so far, the site represents seasonal and permanent habitation at Red Mountain through Soho phase loci.

The Early Formative was characterized by insubstantial architecture and semi-sedentary settlements with a mixed economy of collected resources and irrigation agriculture (Mabry 2000) and a population density that was higher than the preceding phases (Wallace and Lindeman 2003). The mixed economy would have created tension between labor-intensive demands of riverine agriculture for canal construction and maintenance at one location versus movement into uplands where dispersed resources would have required frequent movement. The extent to which people could have left riverine sites to forage in the uplands had to be balanced against the need to preserve land tenure claims (Huckell et al. 2002). Foraging and hunting work groups had to balance the distance traveled and potential shortages caused by over-exploitation of locations close to riverine areas. Forager work groups that were tethered to nearby riverine areas may have experienced lower success rates per capita compared to groups that were able to cover more ground because an increased population pressure would have reduced the abundance of collected and hunted resources in heavily exploited areas (Bayham and Hatch 1985). Thus, there was a cost attendant

upon farmagers that integrated agricultural crops into the seasonal round of foraging. Farmsteads that were close to mountainous areas may have been used for longer periods of a season than farmsteads situated in a broad river valley if work groups were able to exploit upland resources and return to the farmstead.

The bulk of architectural information about the Red Mountain and Vahki phases is from the four sites in the US 60 project area: AZ U:11:7(ASM)/Finch Camp, AZ U:12:72(ASM)/Bighorn Wash, AZ U:12:41(ASM)/Black Dog, and AZ U:12:106(ASM)/Carbonate Copy (Wegener et al. 2011). In these sites and for all phase/period contexts the excavations exposed 62 pit houses (27 pithouses are included in this study) scattered over almost 12 acres of excavations with 112 pits, 19 middens, 21 burials, and miscellaneous feature classes (inclusive of post-AD 700 Hohokam materials), plus 39,733 collected artifacts. Black Dog and Carbonate Copy are entirely within the ADOT right-of-way and cover a total of 4 acres. Finch Camp (37 acres) and Bighorn Wash (6.7 acres) have surface materials covering a combined 31.7 acres located outside the US 60 excavation areas and new discoveries in the unexcavated portions of the sites have the potential to change our perspective each of the site's function, age, and composition. The 12 acres of strip-ping within the US 60's rights-of-way is about 25% of the four archaeological sites' combined size. Based on the materials recovered so far, the four sites represent Late Archaic through Sedentary period habitation and limited activity loci.

The other site contributing a substantial number of features to this study is AZ T:12:70(ASM)/Pueblo Patricio (Cable et al. 1985; Hackbarth 2010, 2012, 2019b; Henderson 1995). AZ T:12:70(ASM)/Pueblo Patricio is close to the Salt River and has 121 pithouses (22 pithouses are included in this study), 107 pits, 9 middens, 4 burials, and other excavated features plus 37,593 collected artifacts reported from more than six project areas that cover approximately 15 acres of excavations (all contexts regardless of phase assignments). Comparing the total number of features and artifact densities in the four US 60 sites to Pueblo Patricio suggests the two areas have some characteristics in common (excavated areas, number of dated pithouses within the study's temporal parameters, excavated pits, and collected artifacts) but differ in others (number of burials, total number of pithouses). Except for Block 24-East (Cable et al. 1985) AZ T:12:70(ASM)/Pueblo Patricio, the rest of the site had a paucity of artifacts in overburden and pithouse fill, small houses, few instances of superposition of features, a low number of extramural pits, and just four burials (Hackbarth 2010, 2012, 2019b; Henderson 1995). Simplifying the equation of US 60 sites and Pueblo Patricio to just all pithouses and burials indicates there were half as many houses in the US 60 sites, but 5x as many burials compared to Pueblo Patricio (all contexts regardless of phase assignments). The high number of pithouses

at AZ T:12:70(ASM)/Pueblo Patricio could be attributed to the proximity of a reliable water supply and multiple, temporary seasonal occupations, whereas the burials at US 60 sites may reflect a longer duration at the sites possibly because the mountains were easily accessible after short trips to upland resources that extended the length of time the US 60 sites could be used before moving into the uplands seasonally. In contrast, AZ T:12:70(ASM)/Pueblo Patricio is located in the middle of the expansive Salt River Valley and only small mountain chains are nearby that could be reached after short trips.

Three features were included from the SR 87 project's investigations of AZ U:6:213(ASM)/La Escuela Cuba (Hackbarth 1992). Most notable is the largest pithouse in the study (Feature 36; 47.7 m<sup>2</sup>) at the center of the 10.9-acre site and its proximity to small and large houses. Mechanical stripping exposed approximately 0.94 acres of the project area, about 19% of the site within the highway right-of-way. Future excavations within the unexcavated portion of the site could change our perspective of the site's function, age, and composition, but extensive testing was conducted within the right-of-way and did not find large numbers of features in areas not stripped.

The percentage of intensive excavations of sites presented in this study is meant to recognize the potential to misinterpret site functions because of the limitations and predictive value of small archaeological samples. Because the range of intensive mechanical excavation ranges from 19% to 97% excavated there is a chance of mischaracterizing a site's composition and function(s). Certainly, the 70 dated pithouses is a very small sample for the two millennia under consideration, especially considering that almost half of all houses in the study are from just the 450 years of the Red Mountain phase. Selecting only the dated pithouses and concentrating on architecture variables may simplify the equation of what is studied (after Krauss 2007), but removing variables increases the standard deviation. The benefit of this strategy, however, is identification of weaknesses in the data that point to questions to be addressed in the future.

## RESULTS

The assembled architectural data documents change in the pithouse architecture as populations of foragers shifted to a more sedentary lifestyle associated with farming. These changes correlate with construction of irrigation canals on river terraces in west Mesa (Canal 61; Henderson 1989) during the late Red Mountain phase (AD 250–450) and near Sky Harbor (Feature 1/South Main Canal at Dutch Canal Ruin; Henderson 2004) approximately AD 290–470. The canals imply a substantially larger population was present compared to the first half of the Red Mountain phase and, in combination, demonstrate an increase in social complexity

that co-occurs with changes in the spatial organization of houses and increases to structures' sizes.

There are far fewer dated structures in the upland sites than the riverine setting (see Table 1). The absence of dated Early Cienega phase pithouses is evidence of how rare Late Archaic occupations are in the Salt River Valley. Dated structures that broadly include the Early Cienega phase are known from the LAFB project area, but the features' indeterminate sizes and shapes precludes their inclusion in this analysis. Nevertheless, the Archaic structures at the Cashion Complex, AZ T:11:94(ASM) offers hope that Early Cienega sites will be discovered in the future, unless erosion or other related factors destroyed sites (after Waters and Kuehn 1996; Waters and Ravesloot 2001).

A summary of the most common house characteristics for each phase is provided in Table 3. Variability of house characteristics is high within and between phases and it is rare that any one house is configured with all the most common elements. This architectural diversity reinforces that occupations should not be expected to be monolithic in terms of house shapes and sizes. Examples of selected houses are depicted in Figures 2–4 and a visual summary of house characteristics is presented in Figure 5.

### San Pedro Phase

The San Pedro phase houses are the earliest architectural features in the study, but they are from just one site (AZ T:7:419[ASM]/Falcon Landing). Nine directly dated San Pedro phase houses are in the study. One of the nine houses (Feature 18192, AZ T:7:419[ASM]/Falcon Landing) has superimposed upper and lower floors, providing two to the total of ten floors included in this study. The median feature size for San Pedro structures (2.63 m<sup>2</sup>) is significantly smaller than later time periods (see Table 3).

One hearth is present among the ten floors (Feature 18192, AZ T:7:419[ASM]/Falcon Landing), and only two others (Features 2622 and 18887, AZ T:7:419[ASM]/Falcon Landing) have any evidence of burning that could be construed as a hearth. Protruding entrances are equally rare, with only one house having a ramped entryway. Five of the houses have between 3 and 26 postholes, but four structures lack any postholes. Subfloor pits are relatively common: eight of ten floors have one or two intramural pits.

Floor shapes of the San Pedro phase houses are mainly circular, but three other shapes are present among the ten house floors. Only one floor (Feature 18192, AZ T:7:419[ASM]/Falcon Landing) was prepared, and it was the upper of two floors in a house. The median size of San Pedro floors is 2.63 m<sup>2</sup> with a range of 1.10 to 7.04 m<sup>2</sup>. One structure (Feature 13071, AZ T:7:419[ASM]/Falcon Landing) is more than 1.5x larger than the median floor and is nearly the size of the earliest structures recorded in the Salt River Valley at the Cashion Complex, AZ T:11:94(ASM) (Graves et al. 2011).



**Table 3. Summary of dated house characteristics by phase.**

House variables	San Pedro (n=9)	Late Cienega (n=10)	Red Mountain (n=34)	Vahki (n=17)
Floor size	Range = 1.1 to 7.04 m <sup>2</sup> Mean = 3.2 m <sup>2</sup> Median = 2.63 m <sup>2</sup>	Range = 5.3 to 16.1 m <sup>2</sup> Mean = 8.65 m <sup>2</sup> Median = 7.25 m <sup>2</sup>	Range = 2.5 to 47.7 m <sup>2</sup> Mean = 10.29 m <sup>2</sup> Median = 9.0 m <sup>2</sup>	Range = 2.5 to 36.2 m <sup>2</sup> Mean = 14.37 m <sup>2</sup> Median = 12.7 m <sup>2</sup>
Floor shape	Circular = 6 Oval = 1 Subsquare = 1 Bean = 1	Circular = 4 Oval = 3 Subrectangular = 2 Rectangular = 1	Circular = 14 Oval = 8 Subrectangular = 5 Rectangular = 3 Subsquare = 2 Bean = 1 Irregular = 1	Circular = 5 Oval = 5 Subrectangular = 3 Rectangular = 1 Subsquare = 3
Floor preparation	Prepared = 1 <sup>a</sup> Unprepared = 9	Prepared = 0 Unprepared = 10	Prepared = 8 Unprepared = 27 <sup>b</sup>	Prepared = 4 Unprepared = 13
Hearths	None = 8 1 or more = 1	None = 4 1 or more = 6	None = 8 1 or more = 26	None = 9 1 or more = 8
Entry	None = 8 Ramped = 1	None = 8 Level = 2	None = 13 Level = 11 Ramped = 6 Ramped and step = 1 Level and ramped = 1 Two steps = 1 Internal = 1	None = 10 Level = 3 Ramped = 3 Ramped and step = 1
Postholes	No posts = 5 Multiple posts = 4	No posts = 0 Multiple posts = 10	No posts = 5 Multiple posts = 26 Wall trench = 1 Double row posts = 2	No posts = 2 Multiple posts = 13 Wall trench = 2
Intramural pits	No pits = 2 1 or 2 pits = 8 <sup>a</sup>	No pits = 2 1 or 2 pits = 7 More than 2 pits = 1	No pits = 10 1 or 2 pits = 15 More than 2 pits = 9	No pits = 8 1 or 2 pits = 6 More than 2 pits = 3

<sup>a</sup> One house (Feature 18192, T:7:419(ASM)/Falcon Landing) has two floors, which accounts for more floors than total number of houses; only the upper floor was prepared and the lower floor has 1 subfloor pit only.

<sup>b</sup> One house (Feature 14702, AZ T:7:419(ASM)/Falcon Landing) has two floors which accounts for more floors than total number of houses; both floors were unprepared, three intramural pits in the upper floor only.

### Late Cienega Phase

Ten directly dated Late Cienega phase houses are present: one from an upland site (AZ T:7:419 [ASM]/Falcon Landing) and nine structures from a riverine setting at AZ U:11:7(ASM)/Finch Camp. Most houses have one hearth, which is a major difference from the earlier San Pedro phase. Protruding entries are generally absent, but in two structures (Features 1540 and 2120, AZ U:11:7([ASM]/Finch Camp) there is a level surface extending outside the floor outline that could be entries. Most structures have more than a dozen postholes, and only two structures have fewer than eight postholes. The number of pits is relatively high and all ten Late Cienega floors were unprepared. Circular house floor plans are the most common, but oval and two rectilinear shapes are present. The median house size is 7.25 m<sup>2</sup>, with a range of 5.3 m<sup>2</sup> to 12.5 m<sup>2</sup>.

The Late Cienega phase sample has a particularly notable structure situated at an upland site. Feature 2120 at AZ U:11:7(ASM)/Finch Camp (see Figure 3)

has the most postholes (n=42), a protruding entry, a large floor size (12.5 m<sup>2</sup> compared to the median of 7.25 m<sup>2</sup>), a subrectangular floor plan, and a neonate burial in a subfloor pit. All these characteristics could indicate a unique structure possibly used by a prominent household (Wegener and Ciolek-Torrello 2011:165–169).

### Red Mountain Phase

Red Mountain phase houses with direct chronometric dates are found in both the uplands (n=4) and in riverine settings (n=30). The large number of dated structures from this phase probably results from the recent widespread availability of AMS plus a convergence of Morris' (1969) identification of the phase after the initial Hohokam sequence was proposed (Gladwin et al. 1937) and Dean's (1991) hopeful comments for dating the phase. The ability to date small fragments of charred materials probably has contributed to the large number of dated samples from recent excavations.

The Red Mountain phase exhibits considerable architectural variability that corresponds to the large number of houses in the sample. The most common architectural trait for the otherwise diverse group of dated houses is the presence of hearths—25 houses have 1 hearth, 8 houses have no hearths and one struc-

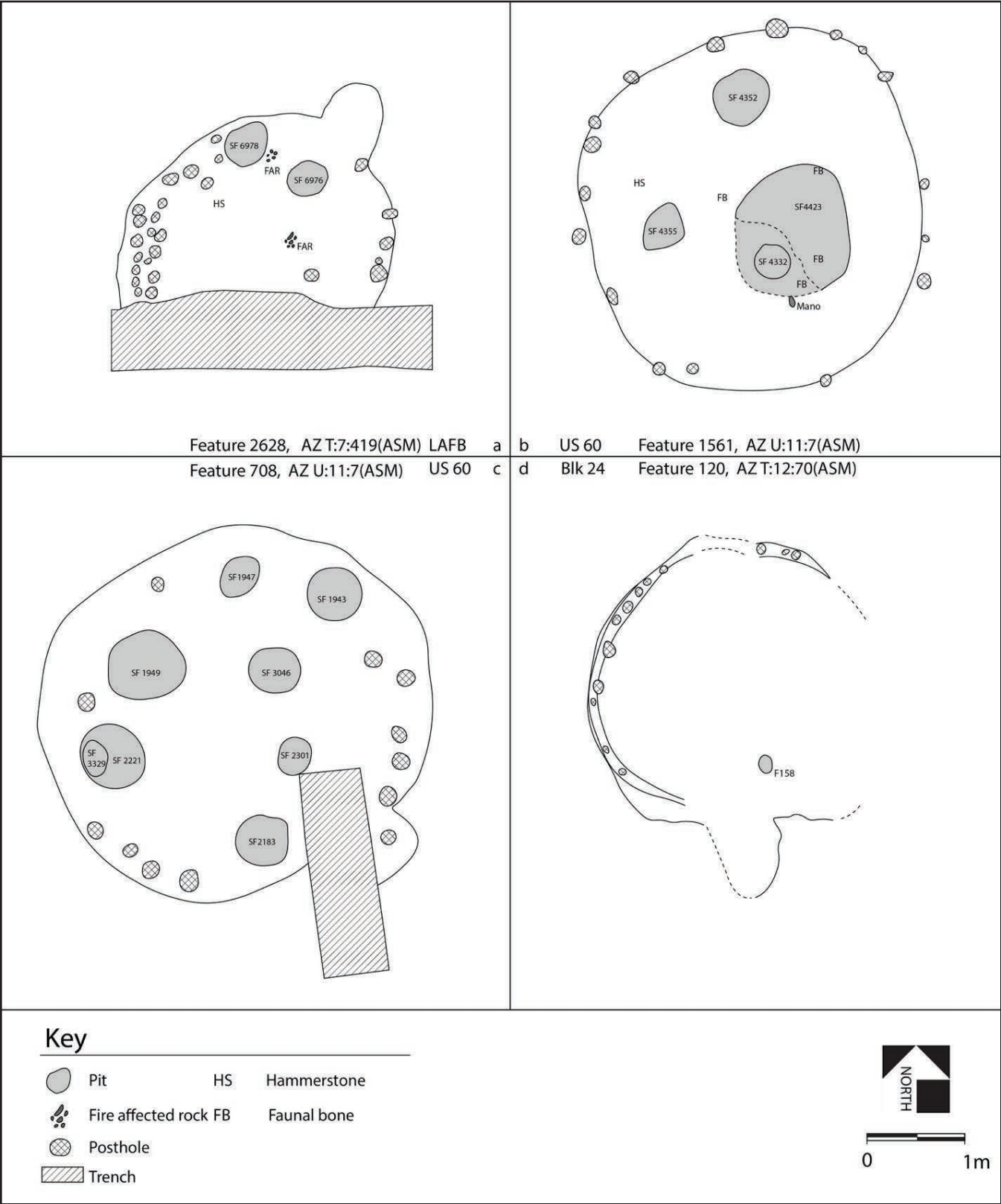


Figure 2. Representative floor plans (a=San Pedro, b=Late Cienega, c=Red Mountain, d=Vahki phases).

ture (Feature 2215 in AZ U:11:7[ASM]/Finch Camp) has 2 hearths. Projecting entries become much more common than the earlier phases but there is considerable variability in entry shape: 13 structures lack a projecting entry, 12 have level entries, and the 9 remaining entries are a mix of steps, ramps, and one has a raised internal step. Postholes are present in almost all houses, but in only three cases are there double rows of posts or a wall trench. Twenty-six structures have intramural pits and ten lack any subfloor pits, a frequency that is less than the preceding Late Cienega phase houses.

Red Mountain phase houses included 26 unprepared floors, 8 prepared floors, and one structure with 2 floors (Feature 14702 in AZ T:7:419[ASM]/Falcon Landing); the upper prepared floor was created by adding dirt above an unprepared floor, which brings the floor count (n=35) to one more than the house count (n=34). The median floor size was 9.0 m<sup>2</sup> for all Red Mountain phase structures. However, the largest structure (Feature 36 in AZ U:6:213[ASM]/La Escuela Cuba; 47.7 m<sup>2</sup>) was more than twice as large as the next largest house (Feature 758 in AZ T:12:70[ASM]/Pueblo Patricio; 21.07 m<sup>2</sup>). The <sup>14</sup>C sample from Feature 36 has a long 2-sigma range (see Appendix A) that indicates it could be a Red Mountain or Vahki phase house. Floor shapes

of the Red Mountain phase houses exhibit considerable diversity and are divided among seven types, the most common is a circular floor (41.1%) (see Table 3).

### Vahki Phase

The former Estrella and Sweetwater phases of the Pioneer period have been subsumed under the term Vahki phase, following Craig (2001:141). Sixteen dated structures in the sample are classified as Vahki phase. The most common floor shape is circular (n=5; 31.2%), a decrease in the frequency of circular forms from the preceding Red Mountain phase (41.1% of dated houses). If the rectilinear Vahki phase shapes (1 rectangular, 3 subrectangular, and 3 subsquare) are grouped together then they would become the most common floor shape, similar to the observed trend for rectilinear house-in-pit structures to be more common after AD 400 (Lindeman and Wallace 2004:116). The few dated examples in each shape classes, however, reinforce the need to consider sample size and whether large or small regional summaries could accentuate or mask such differences.

Unprepared floors are 3x more common in the Vahki phase than prepared floors (12 versus 4, respectively), and hearths are equally split between 8 houses

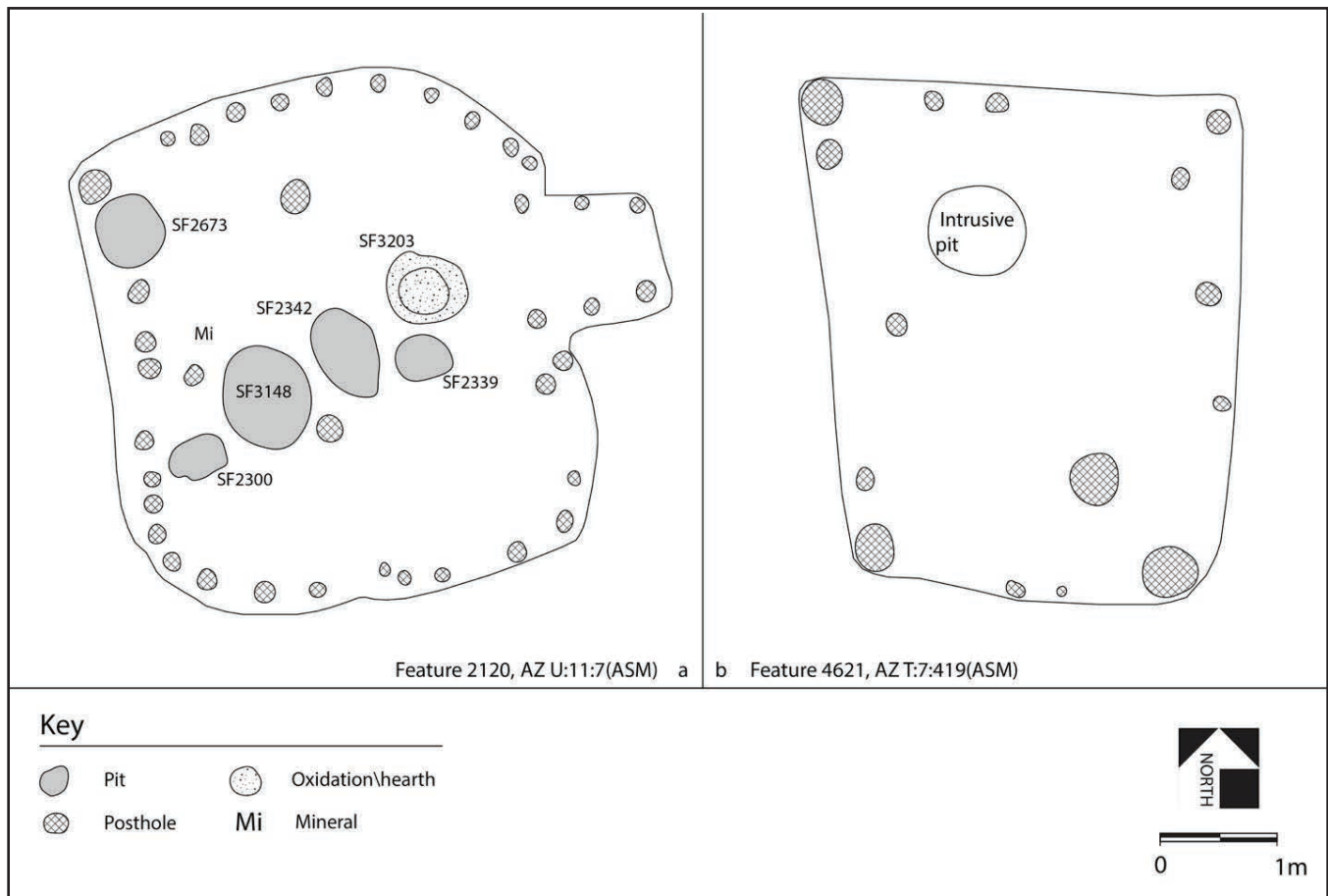
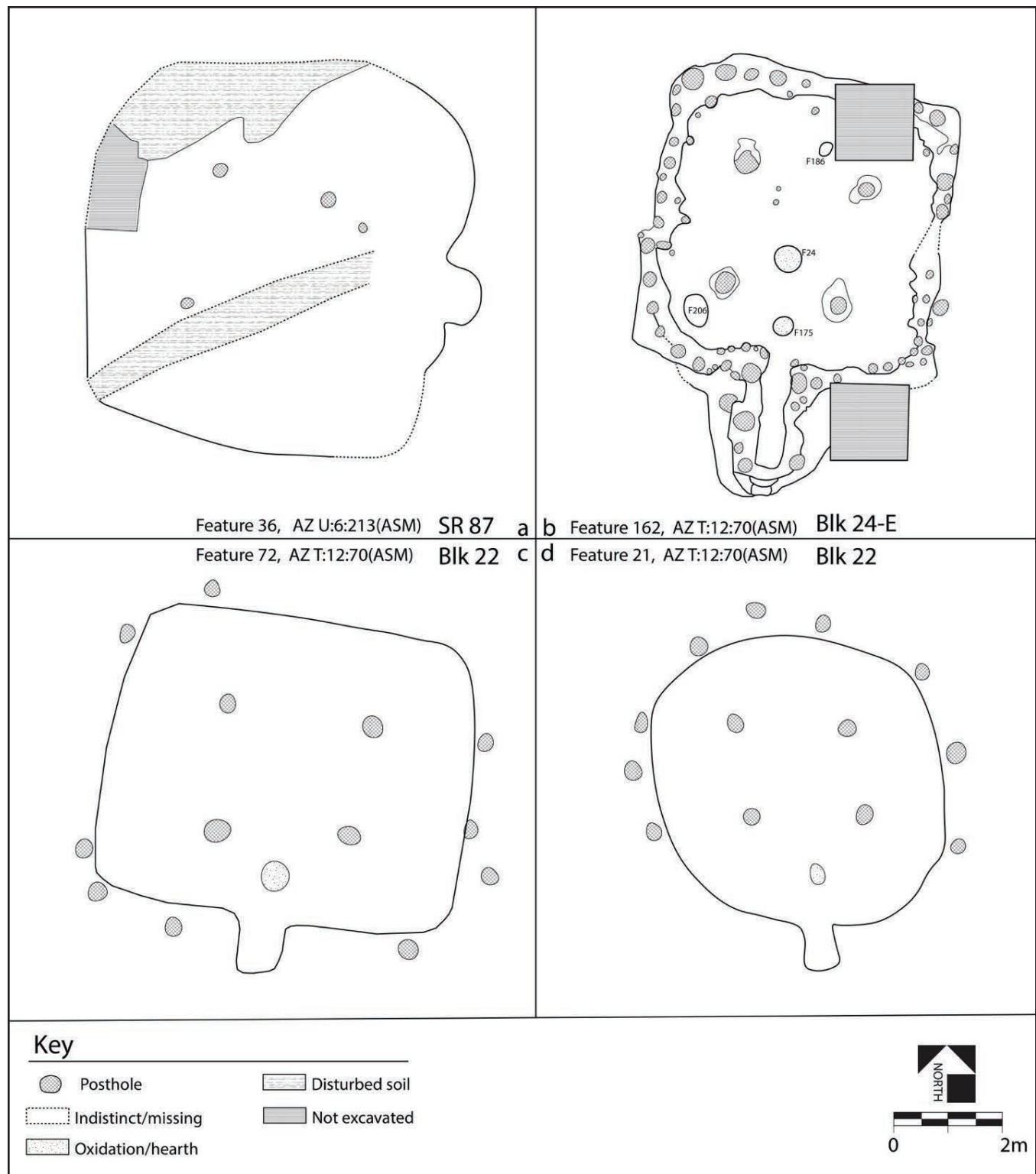


Figure 3. Representative floors of early large structures (a=Late Cienega, b=Late Cienega)



with hearths and 8 that lack hearths. The presence of subfloor pits also is equally divided, and postholes are very common. Ten structures lack a protruding entry, and the six houses with entries are divided among three entry shapes. The number of dated Vahki phase structures (n=17) is half of the Red Mountain phase houses (n=34). At a time when the population is likely increasing, the fewer dated Vahki phase houses could point to missing archaeological data. Alternatively, the difference could reflect either the Red Mountain



**Figure 4. Representative floors of late large structures (a=Red Mountain/Vahki, b=Red Mountain/Vahki, c=Vahki, d=Red Mountain/Vahki).**

phase's semi-sedentary population building more houses and abandoning them after brief uses or else the Vahki phase's construction of fewer houses but using them for longer periods of time. Regardless, the numbers of dated features in the current sample of Red Mountain and Vahki phases is disproportionate for the assumed population size.

The median size of Vahki phase houses is 12.7 m<sup>2</sup>, but four Vahki phase houses are considerably larger. Three of the four largest houses in the current study (Features 21, 72, and 162 in AZ T:12:70[ASM]/Pueblo Patricio) are concentrated in one portion of the site only 150 m apart from each other. Cable (personal communication 2019) points to this concentration of three presumed community houses at AZ T:12:70(ASM)/Pueblo Patricio as evidence consistent with his initial conclusion of a village-level organization (Cable and Doyel 1987; Cable et al. 1985). Pioneer though Classic period houses are found in low numbers elsewhere in AZ T:12:70(ASM)/Pueblo Patricio (Cable et al. 1982; Cable et al. 1983; Cable et al. 1984; Henderson 1995) that could narrowly support an interpretation of AZ T:12:70(ASM)/Pueblo Patricio as a village. Likewise, synchronic evidence of large square P-3 and P-4 pithouses along with plazas and cemeteries is evidence of villages at Snake-town (Wilcox et al. 1981), Valencia Vieja, and nine other sites (Wallace 2003:331–346). However, the defining characteristic of P-3 and P-4 houses as community integrative facilities in a village is not their size, but rather their orientation towards a plaza, associated ritual paraphernalia, and community cemeteries (Wallace 2003:339). At Valencia Viejo multiple large and small square Pioneer period structures located away from the plaza in the village are interpreted as residential houses of newly arriving lineage heads that migrated into the site after its founding (Wallace 2003:331–346). Only the P-3 and P-4 houses facing the plaza are interpreted to be community rooms and the center of a village (Wallace 2003:331–346).

I suggest the three large Vahki phase houses at AZ T:12:70(ASM)/Pueblo Patricio are evidence of sequentially-built structures, possibly newly arriving lineage heads at the site. Previously, I considered Feature 21 (a circular true pithouse) as a foundation house of the first occupants (Hackbarth 2012). If correct, Features 72 and 162 (both subsquare true pithouses) could be the houses of later arrivals. This building sequence of circular and square true

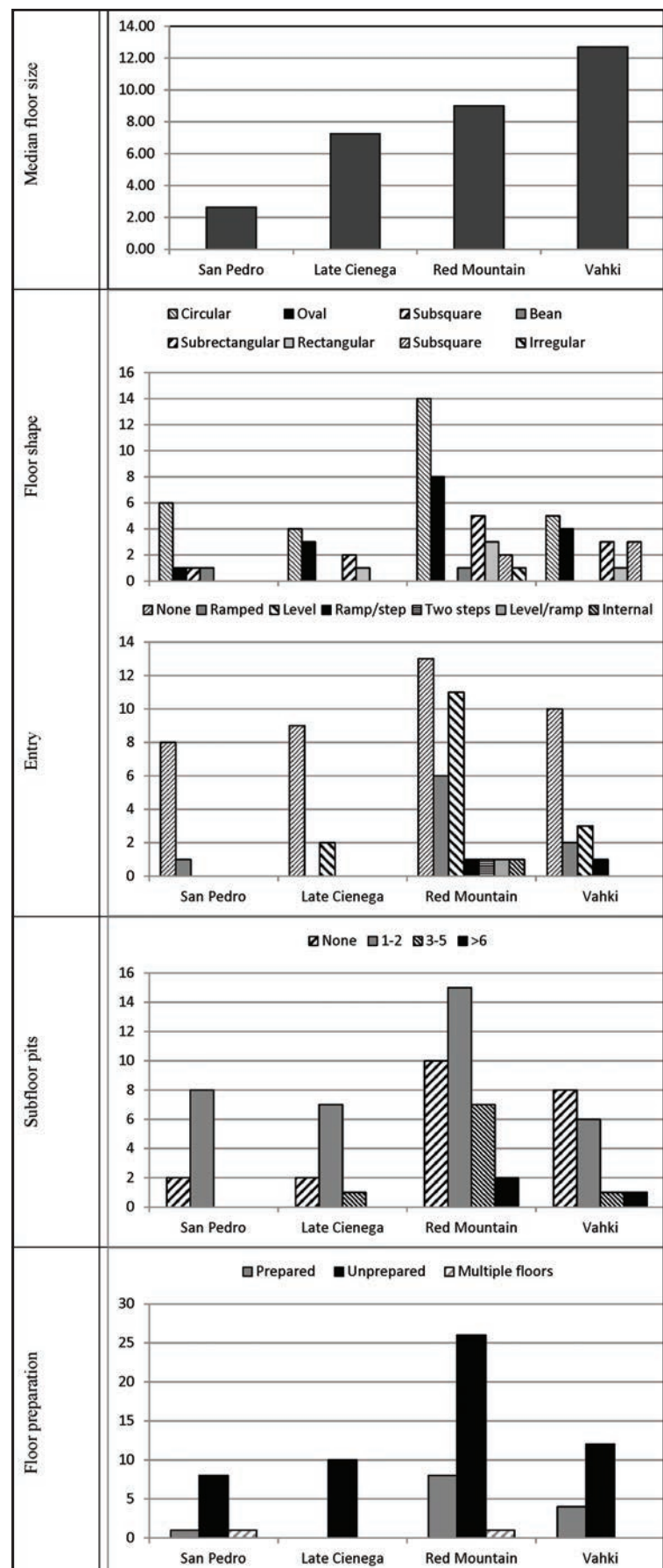


Figure 5. House characteristic frequencies.

pithouses fits with the sequential transition of Plain Ware and Red Ware house forms noted by Lindeman and Wallace (2004). The dates of the three large houses at AZ T:12:70(ASM)/Pueblo Patricio span the end of the Red Mountain and beginning of the Vahki phase and could represent the culmination of a Red Mountain phase settlement of repeated small, short-term, seasonally reoccupied habitation nodes that briefly became a larger settlement in Block 24-East. The Block 24-East project area has a high density of features ( $n=39$  in one acre), some of which were superimposed upon others (Cable et al. 1985). The density does indicate a more intensive occupation than the rest of the excavated areas in the site, which averages 17 features per acre (Cable et al. 1982, 1984; Hackbarth 2010, 2012; Henderson 1995). The number of collected artifacts is likewise skewed with an average of 294 collected artifacts per feature in Block 24-East, but an average of only 46 collected artifacts per feature in the other project areas. Features surrounding Features 21 and 72 at AZ T:12:70(ASM)/Pueblo Patricio and elsewhere are generally devoid of post-abandonment refuse above pithouses (indicating minimal sequential occupation), have faint soil distinctions for pithouse outlines (indicating minimal construction materials used in houses), small house sizes (indicating a low population and seasonal occupation), and rarity of human remains (Hackbarth 2012, 2019b; Henderson 1995), all of which indicates brief re-occupations of the area. Only four burial features have been reported within AZ T:12:70(ASM)/Pueblo Patricio (Cable et al. 1985; Hackbarth 2010) despite excavations of more than 15 acres in the site, and none of the burials were close enough to each other to form a cemetery. The brief florescence of occupation within Block 24-East of AZ T:12:70(ASM)/Pueblo Patricio, but nowhere else within the site, may indicate the Block 24-East vicinity attained a denser occupation in the Pioneer period than other portions of the site, but the few features from later time periods indicates failure to achieve a level of occupation comparable to a village.

The absence of a village at AZ T:12:70(ASM)/Pueblo Patricio also is suggested by the orientation of the three large houses. If a village was present and the large structures were community rooms, then the large houses should face a plaza and the site should have formal cemeteries in or near the plaza. All three houses are oriented to the south, towards the Salt River. Excavations conducted south, southeast, and southwest of the three large houses have not encountered a plaza to date (Jackman et al. 1999; Mitchell et al. 2017; Rogge et al. 1992) although approximately one acre remains untested. Moreover, there is a large village with one or two plazas and substantial Pioneer period houses at AZ T:12:159(ASM)/La Villa (Lindeman 2015, 2016), only one mile to the west that was the focus of Pioneer period and later settlement in the area.

## DISCUSSION

Dated features in this study produced one temporal gap during the Early Cienega phase (800–400 BC). At least 11 features in the LAFB project area are from this phase, but their dates are insufficiently precise and floor preservation is too poor to be included in this study. This poor preservation could be happenstance, or it could signal a time period when environmental conditions were not conducive to preservation of houses and charcoal (after Waters and Kuehn 1996; Waters and Ravesloot 2001). Regardless, this dearth of dated Early Cienega features is a shortcoming that archaeologists should be aware of during future investigations.

Several other patterns are discernible in the data. The San Pedro phase has the most glaring lacuna of dated features—none are from a riverine setting. All directly dated San Pedro phase houses are from AZ T:7:419(ASM)/Falcon Landing, an upland site. These houses have unprepared floors and intramural pits with only one (Feature 2967, AZ T:7:419[ASM]/Falcon Landing) lacking an intramural pit. The median floor size of San Pedro houses is 2.63 m<sup>2</sup>, considerably smaller than two known Archaic habitation features in a riverine setting (Features 40 and 82 at Cashion Complex, AZ T:11:94[ASM]), which have floor areas of approximately 7.1 m<sup>2</sup>, but close to the size of two houses at AZ U:5:33(ASM)/Last Ditch whose oval outlines measure 2.04 m by 1.43 m (2.27 m<sup>2</sup>; Feature 173) and 2.36 by 2.10 m (3.89 m<sup>2</sup>; Feature 227). These Middle Archaic houses were in a stratum dated to 2130–1900 BC (Phillips et al. 2001:33). Eleven structures broadly dating to the Archaic are known from the upland LAFB project area, and one structure in the uplands (Feature 13071, AZ T:7:419[ASM]/Falcon Landing) has a size (7.04 m<sup>2</sup>) that is comparable to the size of the two Archaic riverine features.

San Pedro houses in this study were small and lacked entries, hearths, and had low to moderate numbers of postholes suggesting they were temporary storage structures, not habitation features. Ethnographic studies indicate that small, lightly built houses were meant for brief, temporary uses (Kent 1991; Kent and Vierich 1989). Binford (1980) mentions that abundant resources at processing sites are often stored for a short time before being moved to a base camp. Numerous extramural features at AZ T:7:419(ASM)/Falcon Landing demonstrate the site was used to process local resources. In combination, these variables support my contention that the small San Pedro houses at AZ T:7:419(ASM)/Falcon Landing were temporary storage structures.

The presence of subfloor pits inside the San Pedro storage structures is intriguing because they indicate that a valuable resource was left at the site. If correct, hiding goods in subfloor pits may have been an effort to limit resource sharing not just within one's own group, but also to prevent members of outside groups from



discovering the hidden resource (after Wills 1992; Flannery 2002). Multiple social groups with overlapping economic zones may have used the resources available at AZ T:7:419(ASM)/Falcon Landing. People storing goods in the structures could have been concerned that members of other groups would recover items left at the site. Over 500 ground-stone artifacts were found at AZ T:7:419(ASM)/Falcon Landing including 19 extramural pits with cached tools (Hall and Wegener 2017:304); some of the “extramural” caches could have been below lightly constructed structures that were so badly eroded as to be invisible to archaeologists, leaving only the pit with the ground-stone artifacts to be found.

Directly dated Late Cienega phase houses (all but one are from AZ U:11:7[ASM]/Finch Camp) are similar to the San Pedro phase houses in terms of predominately circular or oval plan views, unprepared floors, and absence of a protruding entry. The greatest difference, however, is the larger floor size of the Late Cienega phase houses (median = 7.25 m<sup>2</sup>), which is 2.7x larger than the 2.63 m<sup>2</sup> house size of the preceding San Pedro phase houses. This extreme size difference, however, is probably explained by most of the earlier San Pedro features being storage structures. One structure from an upland site (Feature 4621, AZ T:7:419(ASM)/Falcon Landing; see Figure 3) has a floor size of 10.56 m<sup>2</sup> and the other large Late Cienega phase house is from a riverine setting (Feature 2120, AZ U:11:7(ASM)/Finch Camp) with a 12.5 m<sup>2</sup> floor size, indicating comparable floor sizes in Late Cienega sites. The floor areas of these two large Late Cienega phase structures are nearly 1.5x greater than the other Late Cienega houses. Both large Late Cienega phase houses are rectilinear (rectangular and subrectangular) forms (see Figure 3), a departure from the predominant use of circular and oval shapes for domestic structures dating to this phase (see Table 3). Feature 2120 in AZ U:11:7(ASM)/Finch Camp also was unique because of a neonate burial (Feature 2300) within the house. These unique characteristics imply both features could be structures used by a lineage leader (after Wallace 2003). The fact that large structures of lineage leaders were constructed in both the upland and riverine areas may indicate the group's entire population moved en masse into the uplands, not splitting the group into multiple, small task groups that were dispersed over large areas. If correct, the social group may have been relatively cohesive (after Roth 1992). Upland camps used by the entire social group could have left a site footprint on the landscape similar to the riverine sites, albeit occupied for shorter periods of time. The tantalizing evidence of one large structure in the uplands and one in the riverine settings for the Late Cienega phase does little to explain settlement strategies.

Directly dated Red Mountain phase houses comprise the largest number of structures in this meta-analysis (n=34) with the majority (n=30; 88%) located in a

riverine setting. Dated Red Mountain phase structures in this study were from sites along the US 60 project area near Queen Creek (n=15), multiple downtown Phoenix projects near the Salt River (n=12), LAFB upland sites (n=4), and the State Route 87 project near the Verde River (n=3). Most structures in this group had unprepared floors, hearths, and multiple postholes (typically in a single perimeter rows, plus interior posts) (n=26; 76%). Interior pits (n=24; 70%), circular floor plans (n=14; 41%), and level projecting entries (n=12; 35%) were also common. Floor sizes of the Red Mountain phase structures display considerable variability in both the riverine and upland settings. The median floor size is 9.00 m<sup>2</sup>, which is 1.2x larger than the 7.25 m<sup>2</sup> house size of the preceding Late Cienega phase houses. The four dated upland houses (Features 2529, 3936, 19849, 14702 at AZ T:7:419[ASM]/Falcon Landing) range in size from 3.37 m<sup>2</sup> to 11.45 m<sup>2</sup>, whereas the dated houses in the riverine setting range from 2.5 m<sup>2</sup> to 21.07 m<sup>2</sup>, excluding Feature 36 at AZ U:6:213(ASM)/La Escuela Cuba which is 47.7 m<sup>2</sup>. Feature 36 at AZ U:6:213(ASM)/La Escuela Cuba is excluded from this discussion because it has a lengthy 2-sigma date range (AD 127–590) that overlaps both the Red Mountain and Vahki phases and this study may have incorrectly classified Feature 36 as Red Mountain phase. It is larger than all other structures in this meta-analysis and has some similarities to what Haury (1976) called P-3 and P-4 structures in the Vahki phase. Also, Feature 36 at AZ U:6:213(ASM)/La Escuela Cuba was not oriented towards the nearby river, unlike the three large houses at AZ T:12:70(ASM)/Pueblo Patricio. No evidence of a plaza was apparent at AZ U:6:213(ASM)/La Escuela Cuba, but the project's excavated area did extend 15 m away from the house's entry; if a plaza was present it could have been encountered.

I have alluded to the Red Mountain phase settlement pattern near the Salt River as a series of small, short-term seasonally reoccupied habitation nodes scattered along canals. Henderson (2004:176) has demonstrated that canals were constructed on the north and south river terraces by AD 400 and the floodplain continued to be used at this time as well. Wallace and Lindeman (2003:378) mentions that most Red Mountain phase populations were living a semi-sedentary lifestyle with sites distributed along streams occupied only part of the year, approximately four months of the year (Diehl 1992). The remainder of the year people would have lived in temporary camps elsewhere. It is not that Red Mountain phase sites are unknown in the uplands near Salt River Valley (see AZ T:3:322[ASM] and AZ T:3:323[ASM] in Brown and Crespin 2009), but rather that upland architecture dating to the Red Mountain phase is rare. Despite the longer periods of time spent in the uplands we have far fewer dated structures from upland sites than riverine sites. This may be due to frequent moves, brief occupations, and an absence

of structures at upland sites or the group splitting into smaller task groups that left indistinct remains across the landscape (see Wallace and Lindeman 2003:390–397 for comparable dated upland sites in the Tucson Basin). Evidence could support either scenario: the size of most Red Mountain phase houses in upland and riverine sites are dissimilar—the median floor size is 6.04 m<sup>2</sup> in the uplands (n=4) and 10.2 m<sup>2</sup> in the riverine (n=28), implying fewer people per structure (Brown 1987; Naroll 1962). Perhaps the entire group that resided together in the riverine setting was not foraging together in the uplands. Contradicting this evidence, however, is the observation that the only Red Mountain phase house in the upland, Feature 3936 at AZ T:7:419(ASM)/Falcon Landing was quite large (11.45 m<sup>2</sup>). This one dated house is too small of a sample to address the question of whether entire Red Mountain phase groups moved together into the uplands.

Early domestic structures at AZ T:12:70(ASM)/Pueblo Patricio during the late Red Mountain and/or Early Vahki phases form nascent “courtyard” groups. The courtyards, however, are not formed by houses oriented perpendicular to each other and facing onto a central yard. Instead, two groups of contemporaneous houses in the Phoenix Convention Center project area of AZ T:12:70(ASM)/Pueblo Patricio had parallel orientations faced towards a ramada or work area. The two house groups with chronometric evidence of contemporaneity dated to AD 240–380 and AD 130–350. Three other groups of houses have similar spatial arrangements but little or no chronometric evidence to confirm their contemporaneity (Hackbarth 2010:179–184). These paired structures typically consisted of one substantial rectilinear true pithouse and one less substantially built structure. Henderson (1995:232) discussed similar dyad houses at the Block 24-East project area in AZ T:12:70(ASM)/Pueblo Patricio where proximate Pioneer period house groups typically consist of one rectangular and one or more oval or circular bent pole, brush-dome structures, a pattern that became more commonplace in the Colonial period.

The three largest dated architectural features in the Vahki phase are from two different project areas in AZ T:12:70(ASM)/Pueblo Patricio (Feature 162 of Block 24-East and Features 21 and 72 of Block 22). These three features are true pithouses. All three structures have multiple dates that overlap with Feature 36 at AZ U:6:213(ASM)/La Escuela Cuba (see Figure 4). Assuming all four of these large structures were constructed at roughly the same time, then the overlap of chronometric dates occurs around AD 480–550, the same period Wallace (2003:379–386) describes as experiencing momentous change in settlement, society, technology, and subsistence in the Santa Cruz Basin and when large villages appear after AD 500 (Schlanger and Craig 2012) or AD 400–700 according to Sinensky and Farahani (2018:283).

Setting aside the three largest Vahki phase houses, the other 14 dated Vahki phase structures have a median floor size of 12.18 m<sup>2</sup>, which is 1.3x larger than the 9.00 m<sup>2</sup> house size of the preceding Red Mountain phase houses. Among these 14 houses, the most common house floors are 4 circular and 5 oval shapes, with 5 rectilinear shapes divided among 3 subtypes (see Table 3). Lack of a projecting entry (n=10) remains a common architectural element and unprepared floors (n=12) also are in the majority. Including the three largest houses, nearly equal frequencies are present for hearths (9 lack hearths and 8 have hearths). Intramural pits are also nearly equally split (9 with intramural pits and 8 without intramural pits). In summary, Vahki phase houses are more diverse than the Red Mountain phase houses, even though there are fewer of them.

## SUMMARY

This review of architectural data has implications in two realms. In the realm of archaeological data, the current sample of dated houses indicates a continuum in feature size but with different median floor sizes in the upland and riverine settings. The earliest evidence of architecture in the Salt River Valley is Early Archaic oval and circular houses that measure 7.1 m<sup>2</sup> in size from a riverine setting (Graves et al. 2011; Miljour et al. 2009). Two Middle Archaic houses in an upland setting were ovals that measure 2.27 m<sup>2</sup> and 3.89 m<sup>2</sup> (Phillips et al. 2001:33). Eleven other circular and oval structures of indeterminate sizes from broadly dated contexts are known in an upland setting along with one exceptionally large circular structure measuring 32.34 m<sup>2</sup> in size (Hall and Wegener 2017).

Fragments of Early Cienega houses were noted in the LAFB project (Hall and Wegener 2017) but they were so poorly preserved they were not included in this study. This poor preservation could reflect environmental conditions that erased occupations of that time (after Waters and Kuehn 1996; Waters and Ravesloot 2001). In the following Late Cienega phase the dated house are mostly in riverine settings and only one house is from an upland area. The size of Late Cienega and Red Mountain phase houses are closer to each other than they are to either the preceding or following phases, suggesting a somewhat stable population size (after Brown 1987; Naroll 1962). An increase in house size is noted in the Vahki phase, but again most houses are in riverine settings. Either the Vahki phase people are not using the uplands as much as previous time periods or else site recording of the time period in the uplands is poor. Overall, the architectural sample size is quite small for most of the time periods under consideration in this study.

Comparing house sizes within the four phases indicates there is at least one relatively large structure in each phase. A large house in each phase could have a prosaic explanation such as an unusually large house-

hold or, alternatively, the large house could have been the residence of a lineage leader. The small sample size precludes drawing any conclusion at the present time. If the San Pedro and Late Cienega phases had small populations then perhaps leadership positions were only weakly developed, and slightly larger houses were constructed by lineage leaders.

Larger house sizes are noted in the late Red Mountain phase and Vahki phase and their presence is evidence of population growth beginning in the Red Mountain phase. The largest P-3 and P-4 houses at AZ T:12:70(ASM)/Pueblo Patricio and AZ U:6:213(ASM)/La Escuela Cuba are likely indicative of leadership roles that developed in conjunction with the growing population (Hackbarth 2018). At the same time, a shift from plain ware to red ware ceramic production accompanied the larger architecture forms (Lindeman and Wallace 2004). The increasing use of red ware ceramics may be part of a broader cultural change within the group that encompassed a larger population, increased sedentism, and other interrelated variables. Vahki phase is also the beginning of large structures facing onto plazas that served as community integrative facilities, which signals the rise of villages and social differentiation in later time periods (Wallace 2003).

Diverse house shapes that accompany the appearance of large P-3 and P-4 structures during the late Red Mountain and Vahki phases are related to a growing population supported by, and reliant upon, increased agricultural production. Prehistoric canals constructed on upper terraces of the Salt River after AD 400 are probably responsible for increased food resources that supported the expanding population (Henderson 2003). Construction and maintenance of canals required substantial amounts of labor and the village leadership roles developed to organize work groups.

Internal elements of architectural structures become more commonplace and elaborate over time. The presence of prepared floors increases from only one feature in the San Pedro and none in the Late Cienega phases (5.0% of 20 structures in the combined phases) to a high of eight prepared floors during the Red Mountain and Vahki phases (24.0% of 50 structures). A gradual increase in the frequency of hearths also is evident over time, even though the number of hearths never exceeds half of all structures in each phase. The low frequency of a prepared floor and other internal variables may be a product of short-term occupation of sites and lightly built structures because of an intended brief length of stay (after Kent 1991; Kent and Vierich 1989). The presence of intramural pits in houses is higher in the San Pedro (80%) and Late Cienega (83%) phases compared to later time periods in this study, but the average number of pits per house increases over time (San Pedro = 1.3 per house and Late Cienega = 1.5 per house) to a peak in the Red Mountain phase (2 pits per house) before dropping to half as many in the Vahki phase (1.06 pits

per house) (see Figure 5). Wallace (2003) argues that a similar trend is evidence of resource storage involving storage elsewhere in sites, not just in houses.

Postholes are used in the construction of almost all houses, but it is only during the Red Mountain and Vahki phases when double rows of posts and wall trenches appear. Both variables involve more labor than other styles as they involve collection of the posts, construction of the trench, and creating postholes that form the walls. As indicators of an anticipated long stay and extended use of the structure, the wall trenches, double row of postholes and numerous posts per house are associated with more permanent residence co-occurring with development of agricultural and land tenure systems.

This study also has implications in a second realm—the limitations of the existing sample. Previous examinations of architecture noted an increase in rectilinear house forms over time (Lindeman and Wallace 2004; Mabry 2000). However, the persistence of circular houses as the most common form through time in this study may indicate that sampling issues affect the Salt River Valley's data of dated features. The availability of charred materials could be at the crux of why more circular houses were dated than rectilinear houses. A greater risk for fires or intentional burning may have increased the amount of charcoal in circular houses that archaeologists have exploited. Alternatively, archaeologists may have dated more circular structures than rectilinear features to assess whether the houses are from earlier time periods. Either way, future excavation projects may want to direct their chronometric samples to include a wide variety of house shapes to determine whether the current sample of excavated and dated features is representative of variability in the past.

Rectilinear structures are rare in upland sites and only three dated houses were available for this study. Whether that low number is related to the few upland sites with Red Mountain phase components (a temporal trend) or there is a functional (shelter use only, no storage) or practical (ease of construction) reasons for the low numbers remains to be determined. Archaeologists have often treated circular and rectilinear structures as interchangeable types, but circular and rectilinear house shapes are often paired together and could be complementary in terms of function. If the circular, bent-pole structures with chronometric data are auxiliary structures (after Henderson 1995), then dating and sampling them must have an impact on our understanding of the past. If circular houses are dated more frequently but circular and rectilinear house forms represent different functions, then we may be missing opportunities to address questions about subsistence or other topics because presumably archaeologists are submitting subsistence samples from dated contexts more than from undated houses.

One last observation about the available sample of dated houses and sites is needed. Dated Red Mountain phase houses are the most common feature class in



this study, but most of the features used in this study are from large sites with multiple components. If Red Mountain phase settlement involved just one or two small structures at sites along canals that were occupied for as little as four months of the year, would single component sites be recognized as important if found in isolation? At AZ T:12:70(ASM)/Pueblo Patricio the Red Mountain phase houses were associated with an average of 46 artifacts per house. Would surface evidence of a site with so few materials be recognized and recorded as a site? Even if it was recognized, would excavations be recommended for such a small site? If Late Archaic sites were similarly small and lacked ceramics, how likely would it be that they would be recommended for excavation? Retrospective meta-analyses like this study are useful for guiding future research and identifying data gaps. Archaeologists should consider whether small, seemingly uninformative sites should be investigated to ensure critical information about Archaic components is not being missed.

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## Appendix A. Architectural information.

Site/Project	Feature number	Date <sup>a</sup>	Shape	Size	Floor	Hearth	Protruding entry <sup>b</sup>	Postholes	Pits	Reference
AZ T:12:70(ASM)/ Pueblo Patricio/ Heritage Square	38	AD. 30–320 cal (2 samples pooled data, 2-sigma)/ Red Mountain phase	Oval	6.08	Unprepared	1	Ramp, 50 cm by 100 cm	4	2	Henderson 1995:30–34
AZ T:12:70(ASM)/ Pueblo Patricio/ Heritage Square	758	AD 90–540 cal (2-sigma, standard <sup>14</sup> C sample)/ Red Mountain to Vahki phase	Rectangular	21.07	Unprepared	1	Level, 90 cm by 50 cm	3	1	Henderson 1995:30, 51–55
AZ T:12:70(ASM)/ Pueblo Patricio/ Heritage Square	834	AD 180–540 cal (2-sigma, standard <sup>14</sup> C sample)/ Red Mountain to Vahki phase	Circular	5.72	Unprepared	1	Level, 50 cm by 85 cm	0	0	Henderson 1995:30, 62–64
AZ T:12:70(ASM)/ Pueblo Patricio/ Heritage Square	755	AD 240–540 cal (2-sigma, standard <sup>14</sup> C sample)/ Red Mountain to Vahki phase	Subrectangular	10.36	Unprepared	1	Level, unknown by 85 cm	22	2	Henderson 1995:30, 47–49
AZ T:12:70(ASM)/ Pueblo Patricio/ Convention Center	209	AD 130–350 cal (2-sigma, standard <sup>14</sup> C sample)/ Red Mountain phase	Subrectangular	13.4	Unprepared	1	Two steps, 141 cm by 69 cm	3	2	Hackbarth 2010:58, A128–A132
AZ T:12:70(ASM)/ Pueblo Patricio/ Convention Center	183	AD 240–420 cal (2-sigma, standard <sup>14</sup> C sample)/ Red Mountain phase	Oval	10	Unprepared	1	0 <sup>c</sup>	7	6	Hackbarth 2010:58, A113–A117
AZ T:12:70(ASM)/ Pueblo Patricio/ Convention Center	193	AD 240–420 cal (2-sigma, standard <sup>14</sup> C sample)/ Red Mountain phase	Bean	6.6	Unprepared	0 <sup>d</sup>	Level and ramp, 1 step	2	1	Hackbarth 2010:58, A121–A125
AZ T:12:70(ASM)/ Pueblo Patricio/ Convention Center	179	AD 250–420 cal (2-sigma, standard <sup>14</sup> C sample)/ Red Mountain phase	Circular	6.4	Unprepared	1	0	17, wall trench	2	Hackbarth 2010:58, A104–A109
AZ T:12:70(ASM)/ Pueblo Patricio/ Convention Center	94	AD 350–570 cal (2-sigma, standard <sup>14</sup> C sample)/ Red Mountain to Vahki phase	Subrectangular	8.1	Unprepared	0 <sup>d</sup>	0	0	1	Hackbarth 2010:58, A51–A54
AZ T:12:70(ASM)/ Pueblo Patricio/ Convention Center	64	AD 420–610 cal (2-sigma, standard <sup>14</sup> C sample)/ Red Mountain to Vahki phase	Subrectangular	>12.8	Unprepared	1	Level, 1 step, 140 cm by 65 cm	6	1	Hackbarth 2010:58, A33–A38
AZ T:12:70(ASM)/ Pueblo Patricio/ Convention Center	98	AD 480–530 cal (2-sigma, 2 samples pooled data, standard <sup>14</sup> C sample)/ Vahki phase	Circular	15.9	Unprepared	1 <sup>d</sup>	0	6	6	Hackbarth 2010:58, A54–A60
AZ T:12:70(ASM)/ Pueblo Patricio/ Convention Center	161	AD 520–640 cal (2-sigma, standard <sup>14</sup> C sample)/ Vahki phase	Circular	9.4	Unprepared	1	0	6, wall trench	0	Hackbarth 2010:58, A88–A91

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**Appendix A. Architectural information (continued).**

Site/Project	Feature number	Date <sup>a</sup>	Shape	Size	Floor	Hearth	Protruding entry <sup>b</sup>	Postholes	Pits	Reference
AZ T:12:70(ASM)/ Pueblo Patricio/ Block 24-East	141	AD 240–640 cal (2-sigma, standard <sup>14</sup> C sample)/ Red Mountain to Vahki phase <sup>e</sup>	Subsquare	16.97	Unprepared	1	0 <sup>c</sup>	41	4	Cable et al. 1985:58–62; Henderson 1995:203–204 <sup>e</sup>
AZ T:12:70(ASM)/ Pueblo Patricio/ Block 24-East	57	AD 260–600 cal (2-sigma, standard <sup>14</sup> C sample)/ Red Mountain to Vahki phase <sup>e</sup>	Rectangular	12.6	Unprepared	1	0 <sup>a</sup>	21	0	Cable et al. 1985:47–49; Henderson 1995:203–204 <sup>e</sup>
AZ T:12:70(ASM)/ Pueblo Patricio/ Block 24-East	89	AD 260–620 cal (2-sigma, standard <sup>14</sup> C sample)/ Red Mountain to Vahki phase <sup>e</sup>	Irregular	20.5	Unprepared	1	Level, 80 cm by 60 cm	21	1	Cable et al. 1985:51–53; Henderson 1995:203–204 <sup>e</sup>
AZ T:12:70(ASM)/ Pueblo Patricio/ Block 24-East	162	AD 420–690 cal (2-sigma, standard <sup>14</sup> C sample)/ Red Mountain to Vahki phase <sup>e</sup>	Subsquare	30.48	Prepared	1	Ramp and step, 30 cm by 200 cm	64	1	Cable et al. 1985:41–45; Henderson 1995:203–204 <sup>e</sup>
AZ T:12:70(ASM)/ Pueblo Patricio/ Block 24-East	120	AD 420–880 cal (2-sigma, standard <sup>14</sup> C sample)/ Red Mountain phase to Pioneer period or Gila Butte phase <sup>e</sup>	Circular	10.17	Unprepared	0	1	15	1	Cable et al. 1985:120; Henderson 1995:203–204 <sup>e</sup>
AZ T:12:70(ASM)/ Pueblo Patricio/ Blocks 1 & 2	10	AD 260–600 cal (2-sigma, standard <sup>14</sup> C sample)/ Red Mountain to Vahki phase <sup>e</sup>	Rectangular	>15.12	Prepared	1	1	12	0	Cable et al. 1982:39–41; Henderson 1995:203–204 <sup>e</sup>
AZ T:12:70(ASM)/ Pueblo Patricio/ Block 22	21	AD 390–550 cal (2-sigma)/ Red Mountain to Vahki phase <sup>f</sup>	Circular	22.89	Prepared	1	Ramp, 75 cm by 59 cm	14	0	Hackbarth 2012:41–48, 96
AZ T:12:70(ASM)/ Pueblo Patricio/ Block 22	72	AD 480–630 cal (2-sigma, 2 samples pooled data)/ Vahki phase	Subsquare	36.2	Prepared	1	Ramp, >85 cm <sup>a</sup> by 75 cm	13	0	Hackbarth 2012:61–67, 96
AZ T:12:70(ASM)/ Pueblo Patricio/ Block 22	59	AD 420–610 cal (2-sigma)/ Red Mountain to Vahki phase	Subsquare	14.4	Unprepared	0	0	16, wall trench	0	Hackbarth 2012:51–55, 96
AZ T:12:70(ASM)/ Pueblo Patricio/ Block 22	69	AD 430–640 cal (2-sigma)/ Red Mountain to Vahki phase	Rectangular	12.18	Unprepared	2	Level, 120 cm by 95 cm	34	0	Hackbarth 2012:55–61, 96
AZ U:11:7(ASM)/ Finch Camp/ US 60	706	AD 130–380 cal (2-sigma)/ Red Mountain phase	Circular	9.2	Unprepared	1	0	3	4	Wegener and Ciolek-Torrello 2011:71, 77–84
AZ U:11:7(ASM)/ Finch Camp/ US 60	708	AD 130–350 cal (2-sigma)/ Red Mountain phase	Circular	9	Prepared	1	Ramped, >46 cm by > 66 cm	12	5	Wegener and Ciolek-Torrello 2011:71, 84–88

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**Appendix A. Architectural information (continued).**

Site/Project	Feature number	Date <sup>a</sup>	Shape	Size	Floor	Hearth	Protruding entry <sup>b</sup>	Postholes	Pits	Reference
AZ U:11:7(ASM)/ Finch Camp/ US 60	1021	AD 680–890 cal (2-sigma)/ Snaketown – Gila Butte phase	Subrectangular	12.7	Prepared	0	0	3	0	Wegener and Ciolek-Tor- rello 2011:71, 91–93
AZ U:11:7(ASM)/ Finch Camp/ US 60	1510	370–100 BC cal (2-sigma)/ Late Cienega phase	Circular	6.3	Unprepared	1	0	8	1	Wegener and Ciolek-Tor- rello 2011:71, 104–107
AZ U:11:7(ASM)/ Finch Camp/ US 60	1511	350–50 BC cal (2-sigma)/ Late Cienega phase	Circular	6.3	Unprepared	1	0	15	2	Wegener and Ciolek-Tor- rello 2011:71, 107–110
AZ U:11:7(ASM)/ Finch Camp/ US 60	1529	200 BC to AD 10 cal (2-sigma)/ Late Cienega phase	Circular	5.3	Unprepared	1	0	16	1	Wegener and Ciolek-Tor- rello 2011:71, 110–112
AZ U:11:7(ASM)/ Finch Camp/ US 60	1530	360–160 BC cal (2-sigma, two samples pooled data)/ Late Cienega phase	Subrectangular	9	Unprepared	0	0	19	2	Wegener and Ciolek-Tor- rello 2011:71, 112–116
AZ U:11:7(ASM)/ Finch Camp/ US 60	1536	360–110 BC cal (2-sigma)/ Late Cienega phase	Oval	6.6	Unprepared	0	0	24	1	Wegener and Ciolek-Tor- rello 2011:71, 118–120
AZ U:11:7(ASM)/ Finch Camp/ US 60	1538 <sup>e</sup>	Pre-dates 180 BC to AD 80 cal (2-sigma)/ Late Cienega to Red Mountain phase <sup>b</sup>	Oval	7.9	Unprepared	1	0	29	2	Wegener and Ciolek-Tor- rello 2011:71, 123–126
AZ U:11:7(ASM)/ Finch Camp/ US 60	1540	180 BC to AD 30 cal (2-sigma)/ Late Cienega to Red Mountain phase	Oval	5.9	Unprepared	0	Level, 90 cm by 86 cm	20	2	Wegener and Ciolek-Tor- rello 2011:71, 126–129
AZ U:11:7(ASM)/ Finch Camp/ US 60	1561	210 BC to AD 10 cal (2-sigma)/ Late Cienega phase	Circular	8.7	Unprepared	1	0	18	0	Wegener and Ciolek-Tor- rello 2011:71, 129–132
AZ U:11:7(ASM)/ Finch Camp/ US 60	1657	AD 60–240 cal (2-sigma)/ Red Mountain phase	Circular	9.2	Unprepared	1	0	23	3	Wegener and Ciolek-Tor- rello 2011:71, 139–142
AZ U:11:7(ASM)/ Finch Camp/ US 60	2010	AD 210–410 cal (2-sigma)/ Red Mountain phase	Circular	6.9	Prepared (?)	1	0	31, double row of wall posts	2	Wegener and Ciolek-Tor- rello 2011:71, 144–147
AZ U:11:7(ASM)/ Finch Camp/ US 60	2062	AD 60–240 cal (2-sigma)/ Red Mountain phase	Circular	10.5	Unprepared	1	Internal entry	17	1	Wegener and Ciolek-Tor- rello 2011:71, 149–152
AZ U:11:7(ASM)/ Finch Camp/ US 60	2079	AD 20–230 cal (2-sigma)/ Red Mountain phase	Circular	2.5	Unprepared	0	Ramp, 64 cm by 50 cm	16	2	Wegener and Ciolek-Tor- rello 2011:71, 152–155
AZ U:11:7(ASM)/ Finch Camp/ US 60	2087	AD 130–340 cal (2-sigma)/ Red Mountain phase	Subrectangular	7.8	Unprepared	1	Ramp and step, 120 cm by 70 cm	41	5	Wegener and Ciolek-Tor- rello 2011:71, 155–157

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**Appendix A. Architectural information (continued).**

Site/Project	Feature number	Date <sup>a</sup>	Shape	Size	Floor	Hearth	Protruding entry <sup>b</sup>	Postholes	Pits	Reference
AZ U:11:7(ASM)/ Finch Camp/ US 60	2089	AD 230–400 cal (2-sigma)/ Red Mountain phase	Circular	5.4	Unprepared	1	Ramp, 120 cm by 60 cm	21, partial double row of wall posts	2, inhumations	Wegener and Ciolek-Torrello 2011:71, 157–160
AZ U:11:7(ASM)/ Finch Camp/ US 60	2091	AD 80–320 cal (2-sigma)/ Red Mountain phase	Circular	4.9	Unprepared	0	0	9	1	Wegener and Ciolek-Torrello 2011:71, 161–163
AZ U:11:7(ASM)/ Finch Camp/ US 60	2120	350–1 BC cal (2-sigma)/ Late Cienega phase	Subrectangular	12.5	Unprepared	1	Level,, 120 cm by 85 cm	42	4	Wegener and Ciolek-Torrello 2011:71, 165–169
AZ U:11:7(ASM)/ Finch Camp/ US 60	2215	AD 70–230 cal (2-sigma)/ Red Mountain phase	Circular	9.1	Unprepared	2	0	27	7	Wegener and Ciolek-Torrello 2011:71, 170–173
AZ U:12:41(ASM)/ Black Dog/ US 60	882	AD 560–665 cal (2-sigma)/ Sweetwater phase	Circular	15.1	Unprepared	0	0 <sup>c</sup>	3	4	Wegener and Ciolek-Torrello 2011: 267, 281–284
AZ U:12:72(ASM)/ Bighorn Wash/ US 60	556	AD 250–420 cal (2-sigma)/ Red Mountain phase	Circular	10.6	Prepared	1	0	18	2	Wegener and Ciolek-Torrello 2011:346, 351–353
AZ U:12:72(ASM)/ Bighorn Wash/ US 60	797	AD 250–420 cal (2-sigma)/ Red Mountain phase	Ovate	4.9	Prepared	1	0 <sup>c</sup>	0	0	Wegener and Ciolek-Torrello 2011:346, 356–359
AZ U:12:72(ASM)/ Bighorn Wash/ US 60	1754	AD 250–440 cal (2-sigma)/ Red Mountain phase	Subrectangular	9.7	Prepared	1	Level, 100 cm by 60 cm	27	3	Wegener and Ciolek-Torrello 2011:346, 370–373
AZ U:12:72(ASM)/ Bighorn Wash/ US 60	1794	AD 230–440 cal (2-sigma)/ Red Mountain phase	Ovate	8.9	Unprepared	1	Level, 120 cm by 33 cm	24	0	Wegener and Ciolek-Torrello 2011:346, 378–380
AZ U:12:72(ASM)/ Bighorn Wash/ US 60	2125	40 BC to AD 130 cal (2-sigma)/ Late Cienega to Red Mountain phase	Subrectangular	8.4	Unprepared	1	Level, 100 cm by 60 cm	31	0	Wegener and Ciolek-Torrello 2011:346, 380–383
AZ U:12:106(ASM)/ Carbonate Copy/ US 60	1333 <sup>h</sup>	AD 340–540 cal (2-sigma)/ Vahki phase	Ovate	9.5	Unprepared	0	Ramp, stem walls, 90 cm by 70 cm	9	3	Wegener and Ciolek-Torrello 2011:431, 459–462
AZ U:6:213(ASM)/ La Escuela Cuba/ SR 87	33	AD 230–550 cal (2-sigma, standard <sup>14</sup> C sample)/ Red Mountain to Vahki phase	Circular	18	Unprepared	1	Ramp, 50 cm by 60 cm	0	0	Hackbarth 1992:63, 552–553
AZ U:6:213(ASM)/ La Escuela Cuba/ SR 87	36	AD 127–590 cal (2 samples pooled data, 2-sigma, standard <sup>14</sup> C sample)/ Red Mountain to Vahki phase	Subsquare	47.7	Prepared	0	Level, 60 cm by 95 cm	4	0	Hackbarth 1992:63, 553–554
AZ U:6:213(ASM)/ La Escuela Cuba/ SR 87	213	AD 144–420 cal (2-sigma, standard <sup>14</sup> C sample)/ Red Mountain phase	Oval	5.9	Unprepared	1	Level, unknown	0	0	Hackbarth 1992:63, 573

**Appendix A. Architectural information (continued).**

Site/Project	Feature number	Date <sup>a</sup>	Shape	Size	Floor	Hearth	Protruding entry <sup>b</sup>	Postholes	Pits	Reference
AZ U:5:33(ASM)/ Last Ditch/ West Locus/ Mayo	8	AD 380–620 cal (2 sigma)/ Red Mountain to Vahki phase	Oval	10.74	Unprepared	1	0	1	0	Hackbarth 1998:50–52
AZ T:7:419(ASM)/ Falcon Landing/ LAFB	2627	840–800 BC cal (2-sigma)/ San Pedro phase	Circular	2.63	Unprepared	0	0 <sup>c</sup>	12	2	Hall and Wegener 2017:175–179
AZ T:7:419(ASM)/Fal- con Landing/ LAFB	2628	840–800 BC cal (2-sigma)/ San Pedro phase	Circular	3.94	Unprepared	0	Ramp, 70 cm by 63 cm	26 Double row of wall posts; floor groove	2	Hall and Wegener 2017:179–184
AZ T:7:419(ASM)/ Falcon Landing/ LAFB	2629	1030–890 BC cal (2-sig- ma)/ San Pedro phase	Circular	4.68	Unprepared	0	0 <sup>a</sup>	12	2	Hall and Wegener 2017:184–188
AZ T:7:419(ASM)/ Falcon Landing/ LAFB	2967	1110–1000 BC cal (2-sig- ma)/ San Pedro phase	Circular	1.39	Unprepared	0	0	0	0	Hall and Wegener 2017:188–191
AZ T:7:419(ASM)/ Falcon Landing/ LAFB	4308	1010–920 BC cal (2-sig- ma)/ San Pedro phase	Oval	2.3	Unprepared	0	0	3	1	Hall and Wegener 2017:195–199
AZ T:7:419(ASM)/ Falcon Landing/ LAFB	11181	1110–1000 BC cal (2-sig- ma)/ San Pedro phase	Subsquare	2.51	Unprepared	0	0	0	2	Hall and Wegener 2017:199–203
AZ T:7:419(ASM)/ Falcon Landing/ LAFB	13071	970–830 BC cal (2-sigma)/ San Pedro phase	Circular	7.04	Unprepared	0	0	7	2	Hall and Wegener 2017:203–207
AZ T:7:419(ASM)/ Falcon Landing/ LAFB	18192	910–810 BC cal (2-sigma)/ San Pedro phase	Circular (2 floors)	3.2	Prepared (upper floor) and unprepared	1 (up- per floor)	0	0 upper floor 0 lower floor	0 upper floor 1 lower floor	Hall and Wegener 2017:207–211
AZ T:7:419(ASM)/ Falcon Landing/ LAFB	18887	1120–1000 BC cal (2-sig- ma)/ San Pedro phase	Bean	1.1	Unprepared	0	0	0	1	Hall and Wegener 2017:211–214
AZ T:7:419(ASM)/ Falcon Landing/ LAFB	4621	390–200 BC cal (2-sigma)/ Late Cienega phase	Rectangular	10.56	Unprepared	0	0	15	0	Hall and Wegener 2017:221–225
AZ T:7:419(ASM)/ Falcon Landing/ LAFB	2529	20 b.c to AD 120 cal (2-sig- ma)/ Late Cienega phase to Red Mountain phase	Ovate	4.22	Unprepared	0	0	2	0	Hall and Wegener 2017:225–229



## Appendix A. Architectural information (continued).

Site/Project	Feature number	Date <sup>a</sup>	Shape	Size	Floor	Hearth	Protruding entry <sup>b</sup>	Postholes	Pits	Reference
AZ T:7:419(ASM)/ Falcon Landing/ LAFB	14702	AD 20–120 cal (2-sigma)/ Late Cienega phase to Red Mountain phase	Ovate (2 floors)	3.37	Added sedi- ment (upper floor) and unprepared	0	Ramp, 120 cm by 75 cm	12	3	Hall and Wegener 2017:230–234
AZ T:7:419(ASM)/ Falcon Landing/ LAFB	3936	AD 130–330 cal (2-sigma)/ Red Mountain phase	Circular	11.45	Unprepared	0	Level, ca 100 cm by 100 cm	14	2	Hall and Wegener 2017:242–245
AZ T:7:419(ASM)/ Falcon Landing/ LAFB	10849	AD 260–430 cal (2-sigma)/ Red Mountain phase	Ovate	7.86	Unprepared	0	0	0	1	Hall and Wegener 2017:245–249
AZ T:7:419(ASM)/ Falcon Landing/ LAFB	1290 <sup>i</sup>	AD 640–670 cal (2-sigma)/ Snaketown phase	Ovate	2.5	Unprepared	0	0	0	1	Hall and Wegener 2017:252–256
AZ T:7:419(ASM)/ Falcon Landing/ LAFB	3321 <sup>i</sup>	AD 650–770 cal (2-sigma)/ Snaketown phase	Ovate	18.14	Unprepared	0	0	14	2	Hall and Wegener 2017:259–262
AZ T:7:68(ASM)/ LAFB	13 <sup>i</sup>	AD 650–780 cal (2-sigma)/ Snaketown phase	Oval <sup>a</sup>	>3.2	Unprepared	0	0	3	0	Hall and Wegener 2017:439–443

<sup>a</sup> AMS date unless noted otherwise; Henderson's (1995) revision of dates from Cable et al. 1985 are used.

<sup>b</sup> Entry measurements are length by width.

<sup>c</sup> Possibly disturbed by excavation.

<sup>d</sup> Informal hearth present as a burned surface near entrance

<sup>e</sup> Radiocarbon and archaeomagnetic dates reevaluated by Henderson 1995.

<sup>f</sup> Another AMS sample is available but is considered an anomalous date.

<sup>g</sup> Feature 1538 at Finch Camp is dated indirectly by intrusive pit.

<sup>h</sup> Feature 1333 at Carbonate Copy is defined as a storage structure (Wegener and Cioleck-Torrello 2011:431).

<sup>i</sup> Phase assignments for Features 1290 and 3321 at Falcon Landing and Feature 13 at AZ T:7:68(ASM) are Snaketown (Hall and Wegener 2017) but include pre-AD 700 used as end of Vahki phase in this study.

# I,000 YEARS A COMMODITY OBSIDIAN PROCUREMENT AND USE WITHIN THE PHOENIX BASIN OF SOUTHERN ARIZONA

Chris Loendorf

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*Although obsidian was only rarely employed during the Archaic period in the Hohokam region of southern Arizona, use of this natural glass became widespread during the pre-Classic period around AD 600 and continued unabated through the late nineteenth century. As a result of its unique physical properties, this stone was largely if not exclusively used to manufacture weapons, specifically small arrow tips. This factor appears to have affected acquisition patterns for this stone, and data suggest that obsidian was primarily obtained as a raw material through trade. Simultaneously, in rare circumstances points appear to have been introduced on the tips of enemy's arrows, points were also sometimes collected as talismans from settings such as battlefields, and obsidian was occasionally acquired from earlier site components. However, considerable evidence demonstrates that the stone was an important commodity, the vast majority of which was obtained through trade with closely allied peoples who lived outside the Phoenix Basin.*

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Despite the fact that obsidian is not available locally, during the Classic period (ca. AD 1150-1500) this volcanic glass was the most common material that was employed to manufacture arrow points within the Phoenix Basin of south central Arizona (Ballenger and Hall 2011; Fertelmes et al. 2012; Loendorf 2012; Loendorf et al. 2013; Marshall 2002; Mitchell and Foster 2011; Mitchell and Shackley 1995; Peterson et al. 1997; Rice et al. 1998; Shackley 1988, 1990, 1995, 2005). However, use of this stone declined somewhat after the Classic period, and previously it was rarely if ever employed to manufacture atlatl dart points during the Archaic period (ca. 8000 BC – AD 600) along the middle Gila River (Loendorf 2012; Loendorf and Rice 2004). The varieties of obsidian that were employed to manufacture arrow points also vary substantially across space and time in the Hohokam region, and these acquisition patterns have important implications for understanding socioeconomic relationships over the course of at least the last 1,000 years in southern Arizona.

Obsidian has properties that are ideally suited for studying exchange and interaction in southern Arizona, and this material appears to have been an important commodity in the sense that it was a useful and valued item throughout much of the archaeological sequence (Bayman 1995; Fertelmes et al. 2012; Loendorf 2012; Loendorf et al. 2013; Marshall 2002; Mills et al. 2013; Mitchell and Shackley 1995; Peterson et al. 1997; Rice et al. 1998; Shackley 2005). Because obsidian does not naturally occur within the Phoenix Basin, people must have acquired all of this stone from outside the basin. Furthermore, fine-grained stones suitable for arrow point manufacture are also uncommon in the Phoenix Basin, and obsidian is a good material for producing small points. Where they occur, obsidian sources are also locally abundant and they occur in restricted deposits, factors which allow more precise determinations of the locations where the stone was obtained. Most importantly, obsidian has geochemical properties that allow source locations to be objectively identified with a high degree of precision (Shackley 2005). It is therefore possible to employ obsidian provenience data to examine the nature of exchange interactions between Phoenix Basin and surrounding populations, as well as relationships among communities within the basin.

## RAW MATERIAL CONSTRAINTS

In order to understand temporal and spatial variation in obsidian use it is first necessary to consider the physical properties of the stone and how they constrain potential uses of the material. Many lithic researchers classify obsidian as the highest “quality” flaked-stone raw material, and the fact that people transported it over long distances suggests it was indeed a highly valued commodity (Callahan 1979; Kuzmin et al. 2002; Shackley 2005; Smith 2015; Tripkovic 2003; Whittaker

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1994). Reasons why archaeologists consider obsidian to be a good raw material include: it is an isotropic stone without a preferred fracture direction, it requires less force to detach flakes, and flake edges are exceptionally sharp (Ellis 1997; Eerkens et al. 2008; Frahm and Hauck 2017; Kuzmin et al. 2002; Shackley 2005:185; Thomas 2012; Tripkovic 2003).

However, this assessment of “quality” does not include impact strength, which is an important aspect of tool performance. This variable describes the ability of an object to resist structural failure when subjected to a rapid collision (Mabry et al. 1988). Furthermore, materials that perform well in some tasks (e.g., warfare) may not be ideal for others (e.g., hunting). Consequently, in order to understand the performance characteristics of a raw material, it is first necessary to define the relevant functional parameters for tools made from them (Knecht 1997). Within the Phoenix Basin, obsidian was nearly exclusively employed to manufacture flaked-stone arrow points, and extensive ethnographic and archaeological evidence suggests that stone points were primarily made for use in large game hunting or conflict with other people (Figure 1; Ahler 1992; Ellis 1997; Keeley 1996:52; Loendorf 2012; Loendorf et al. 2015; Mason 1894; Stevens 1870:564). Because obsidian was largely used for these two tasks, it is possible to more precisely define the relevant performance requirements.

Large animal hunting and human conflict differ fundamentally in that hunting is done to obtain food,

while the intent during warfare is to kill or wound adversaries (Loendorf et al. 2015). Consequently, important differences exist in the design constraints for these two practices. Because of the substantial additional effort required to track a wounded animal as well as the increased probability it will not be recovered, hunting points were designed to kill as rapidly as possible. In contrast, warfare point designs maximized the probability that severe injury or death resulted, regardless of the length of time required (Loendorf et al. 2015). Because differences exist between hunting and warfare functional requirements, the following discussion focuses on essential performance factors that are common to both tasks.

Research shows that impact strength is a fundamentally important characteristic for the performance of projectile points, and the following briefly summarizes a method for quantifying it (Loendorf et al. 2018; Loendorf et al. 2019a). To test the performance of points with different impact strengths, controlled laboratory experiments were conducted using four different raw material varieties. The stones were selected to represent a wide range of impact strength and they included obsidian (two types), chert (two types), basalt (i.e., fine grained volcanic stone, dacite), and siltstone (i.e., argillite, slate/shale, metasediment). In order to measure their strength, a diamond-bladed saw was used to cut slabs from the raw materials. Subsequently a device was used to drop a ball bearing on the slab (Figure 2). Slabs of window glass were employed as control specimens during the experimental runs. The average height and minimum ball drop height at which the slabs broke were then used to estimate the impact strength of the different stones.

The ball drop height data show that the strength of the tested raw materials varied by a factor of 2.6 to 2.8 (Table 1). It should be noted that the kinetic energy data do not incorporate the effects of air resistance on the ball bearing, and because the falling weight impacted a punch, some energy was necessarily lost in this process. However, because both are constants they should not have altered the relative differences observed among the different stones. Importantly, the glass control samples pro-



Figure 1. Examples of large game hunting (top row) and warfare design points (bottom row) from the middle Gila River (adapted from Loendorf et al. 2015).



**Table 1. Toughness values for different raw materials (adapted from Loendorf et al. 2018).**

Material	Avg. Ke ( $\mu$ J)	Minimum Strength ( $\mu$ J/mm)	Average Strength
Government Mountain Obsidian	28379	4095	4573
Mule Creek Obsidian	30359	4579	4739
Window Glass	13200	5238	5440
Whetstone Chert	38279	5774	5807
Basalt	61049	10882	10954
Siltstone	65999	11558	11813

\*Note: Ke = Kinetic Energy;  $\mu$ J = Microjoule; mm = Millimeters

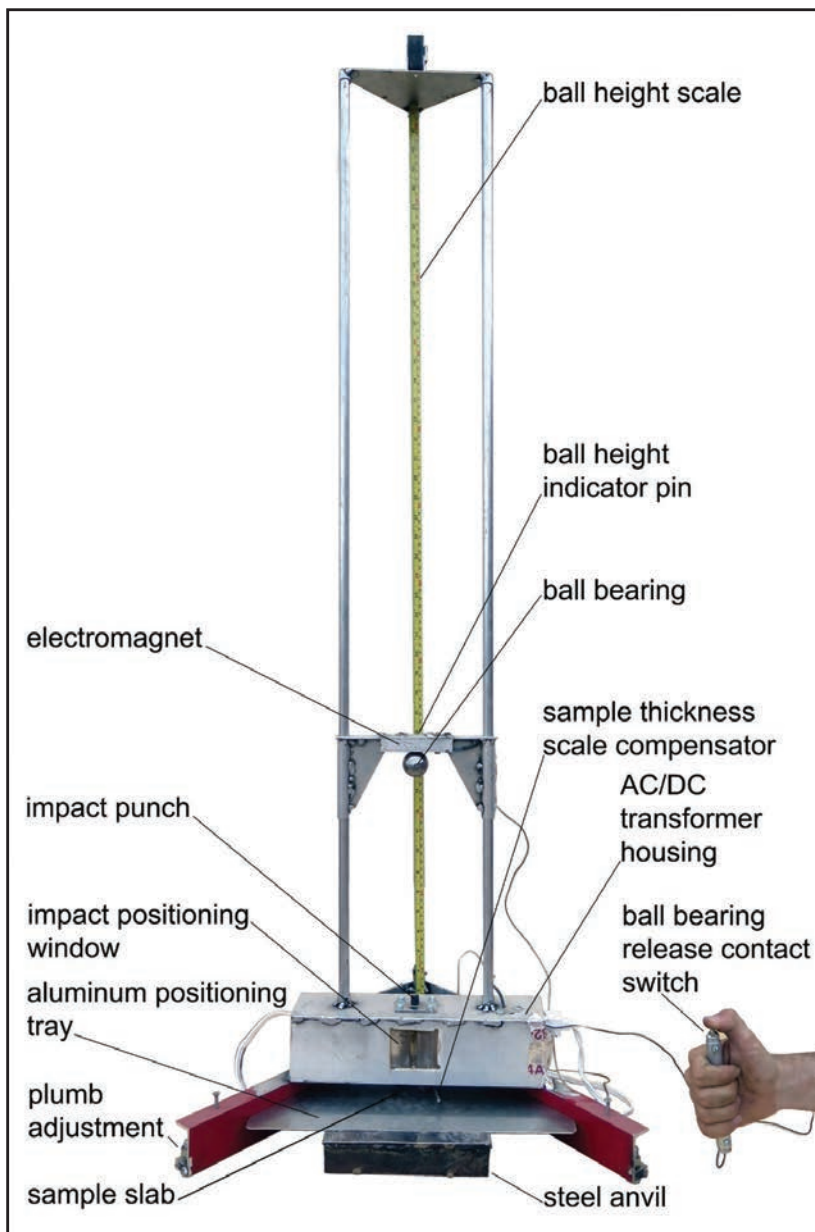


Figure 2. Device employed to quantify raw material impact strength. Built by Lynn Simon (illustration by Robert B. Ciaccio).

vide a reference point for the calibration of the reported results, and these data can therefore also be rescaled to other measures.

In order to test the performance of arrow tips made from stones with varying impact strength, identical projectile points were made from the same raw materials that were employed in the impact strength testing (Loendorf et al. 2018). These points were then hafted on arrows and fired at a series of different targets that were increasingly inelastic, and therefore likely to break the points. In order to minimize variation, all projectiles were fired using a fixed stand that maintained a constant draw length and point of aim (Figure 3). Any points that broke during the trials were reworked and reused until they were too fragmentary for use (Loendorf et al. 2019a).

### Impact Strength and Projectile Point Performance

Instead of simply being the highest “quality” stone, experimental testing showed that obsidian has both strengths and weaknesses. This material provides exceptional performance for penetrating elastic materials like skin, but it also has very low durability and consequently it performs poorly when penetrating inelastic media such as bone (Loendorf et al. 2018). Furthermore, when obsidian points broke, they often suffered catastrophic failures, and it was only rarely possible to rework and reuse them (Loendorf et al. 2019a). It is also more difficult to firmly attach obsidian points to arrow shafts. This characteristic, as well as the poor durability of the material, may have been properties that were preferred for the manufacture of points intended for use in warfare. At the same time, the use of rawhide shields and other types of armor may have limited the effectiveness of obsidian in combat, and lead to the adoption of higher impact strength materials that are more likely to penetrate these defenses (Loendorf et al. 2018). These advantages and disadvantages of obsidian for projectile point manufacture appear to have affected raw material choices over time, which is reflected in data from the

middle Gila region within the Phoenix Basin that are summarized in the next section (Loendorf 2012, 2014; Loendorf and Rice 2004).

### PROJECTILE POINT RAW MATERIAL USE THROUGH TIME IN THE PHOENIX BASIN

Basalt was the most common stone used for the manufacture of Middle Archaic dart points along the middle Gila River (Figure 4; Loendorf and Rice 2004).

It is important to recognize, however, that all fine-grained dark volcanic stone that was non-vitreous was typed as basalt, and it is probable that a range of materials such as more silicic dacite are included in this category (Shackley 2011, 2013; Shackley et al. 2018). In any case, the incidence of the material classified as “basalt” decreased over time, and the stone tested in the impact strength experiments is the same material that occurs in the archaeological collection (Loendorf et al. 2018). The use of basalt subsequently declined until the Classic period when it was again used to make some arrow points. Chert was popular throughout the

sequence, but employment of this material peaked during the pre-Classic period, when it comprised nearly half of all points. As previously discussed, obsidian use was greatest during the Classic period, a pattern that holds throughout southern Arizona (Ballenger and Hall 2011:146–148; Bayman and Shackley 1999; Fertelmes et al. 2012; Loendorf 2014; Loendorf et al. 2013; Marshall 2002; Peterson 1994:103; Rice et al. 1998:110; Shackley 2005).

This patterning in raw material use over time suggests that technological changes such as the introduction of the bow and arrow altered the choice of materials employed to manufacture projectile points. Middle and Late Archaic period atlatl dart tips were rarely made from obsidian, and more durable coarser-grained stones were substantially more common. Another factor that is expected to have influenced material choices is that the size of atlatl darts makes them more difficult to transport, and therefore it is more efficient to carry fewer but more durable weapons (see Ellis 1997:56–63). Furthermore, because they are larger, it is possible to use dart points for a wider range of functions including cutting tasks, which may also have favored the use of durable stone.

This general trend of increasing reliance on obsidian is also consistent with patterning in point types that suggests the proportion of warfare tips increased progressively over time along the middle Gila River (Figure 5). While warfare types are rare for Archaic points, the incidence of this design gener-

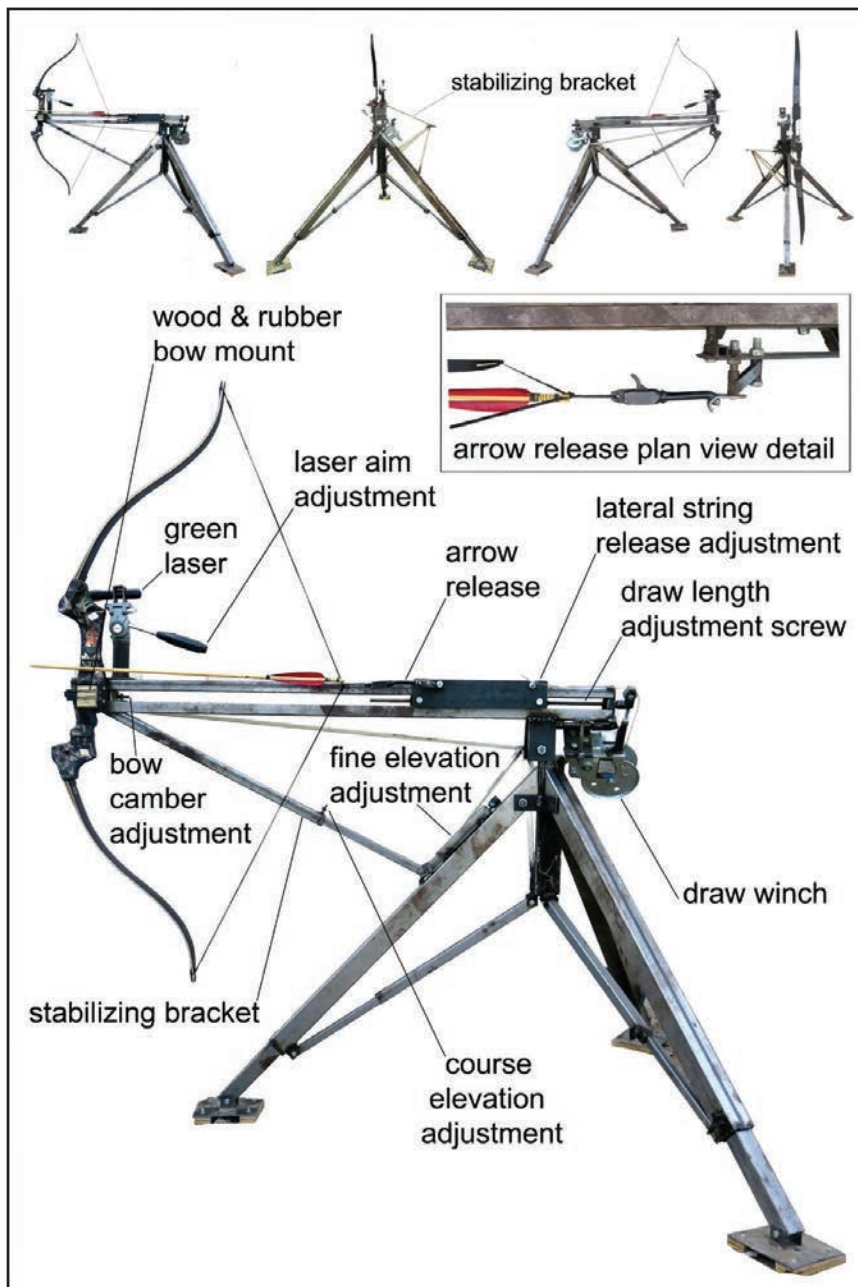


Figure 3. Mechanism employed to test arrow point performance. Built by Lynn Simon (illustration by Robert B. Ciaccio).

## PHOENIX BASIN OBSIDIAN DATA

When considering raw material source information, it is essential to first recognize that obsidian in some instances was used to manufacture arrow points that were employed to tip projectiles used in conflict with other people (Loendorf 2012). While some other goods may have been more readily traded among social groups, the use of flaked-stone points in warfare is expected to have restricted patterns of exchange for the materials, including obsidian, necessary to manufacture these weapons. Indeed, multiple lines of evidence show that obsidian was largely exchanged among more closely allied peoples in the Southwest.

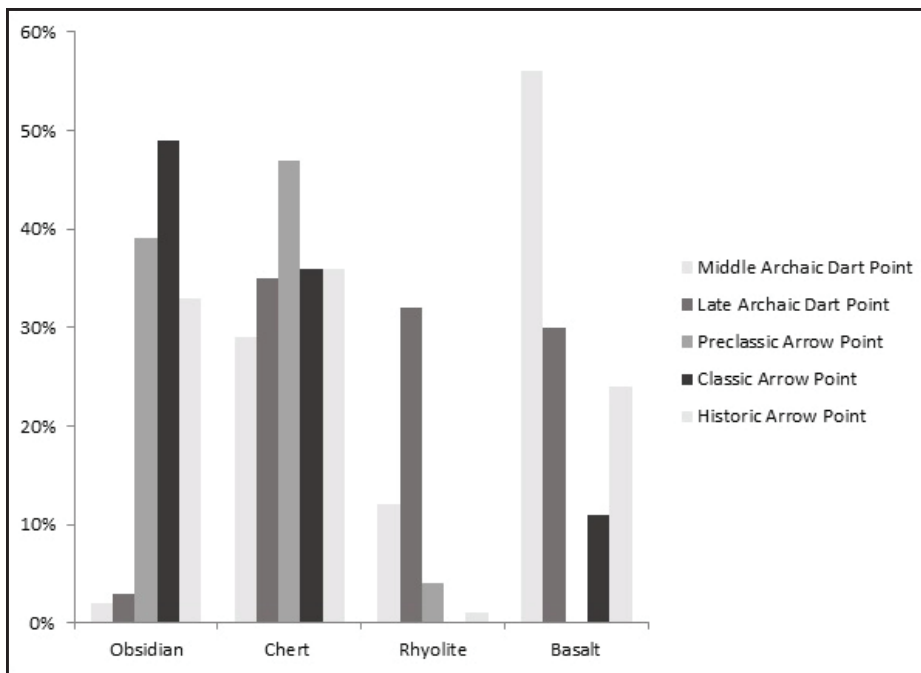


Figure 4. Projectile point raw material by period of manufacture. Gila River Indian Community surface collection data.

ally increased over time, and by the Historic period most if not all points have design features that suggest they were made for use in conflict with other people, and considerable evidence exists that intense conflict occurred at this time (Loendorf et al. 2013; Seymour 2010, 2011a, 2011b, 2017; Wilson 2014). At the same time, the experimental data show that obsidian performs poorly when penetrating even relatively thin rawhide, and the use of rawhide armor may have limited the effectiveness of obsidian in combat. Based on archaeological data including rock art, Baldwin (1997:11-14) argued that thick rawhide shields were introduced to the Southwestern United States by Apachean populations around AD 1400, and the increase in the use of higher strength basalt in late Classic period and early Historic periods may have been an attempt to overcome this defense.

Finally, although some researchers have suggested that the breakup of the pre-Classic ballcourt regional system disrupted obsidian exchange, temporal patterning in the data do not clearly support this hypothesis (Abbott 2009; Abbott et al. 2007; Fertelmes et al. 2012). Research designed to test this possibility only showed a slight possible drop in obsidian use during the period immediately after ballcourts were no longer used, and Phoenix Basin data consistently show a substantial increase in the use of obsidian during the Classic period (Ballenger and Hall 2011; Fertelmes et al. 2012; Loendorf et al. 2013; Marshall 2002; Shackley 2005). Consequently, it is apparent that procurement of this material was not dependent on distribution through the theorized ballcourt marketplace system.

These data include distance decay relationships, and within the Phoenix Basin, direction of the source has a greater effect on raw material utilization than does distance, and obsidian proportions are only weakly correlated with source distances (Bayman 1995:49; Bayman and Shackley 1999; Loendorf 2012:107-115; Loendorf et al. 2013; Mitchell and Shackley 1995:299; Rice et al. 1998). As an example of this patterning, Figure 6 shows obsidian proportions for Pueblo Grande

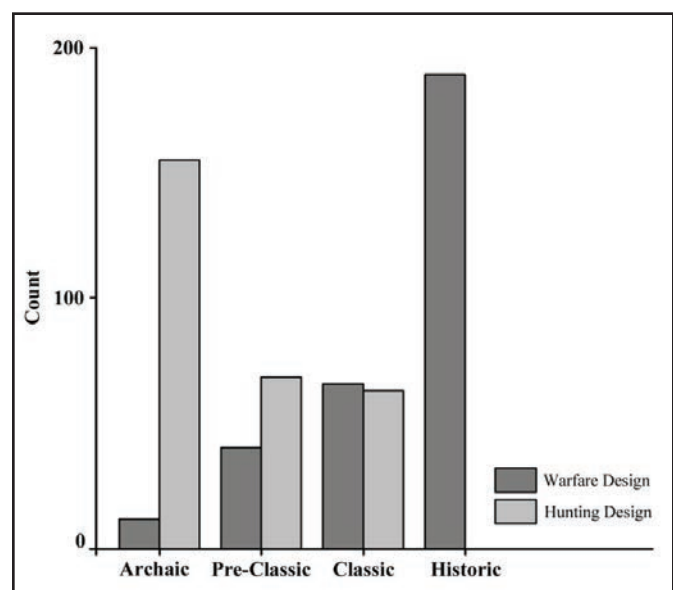


Figure 5. Counts of warfare and hunting point designs over time, Gila River Indian Community surface collection.



(AZ U:9:1[ASM]) along the Salt River, and Lower Santan (GR-522 [GRIC-CRMP]) along the middle Gila River, two sites that are roughly only 35 km apart (Figure 7). As can be seen in these data, sources located to the south of the Phoenix Basin are substantially more common at Lower Santan, while sources from north of the basin are much more common at Pueblo Grande. Furthermore, the most abundant sources such as the Saucedo Mountains are located over 100 km away, and although Pueblo Grande is only roughly 10 percent more distant, it has less than half as much Saucedo obsidian as Lower Santan. If people from the Phoenix Basin were walking to the sources themselves to obtain obsidian, then distance should be the primary factor affecting source proportions. The observed patterning instead is consistent with expectations for trade in which outside populations brought materials for exchange to the basin.

Further evidence that obsidian was a commodity that was primarily obtained through trade is provided by the fact that most of this stone appears to have arrived in the Phoenix Basin as an unreduced raw material. In general, obsidian debitage in all stages of reduction, including unworked nodules, cores, and various flake types is found at Phoenix Basin archaeological sites, which would not be the case if finished points or partially reduced nodules (i.e., flake blanks or preforms) were generally acquired (Bayman 1995; Bayman and Shackley 1999; Loendorf et al. 2013; Marshall 2002; Peterson

et al. 1997; Shackley 2005). Producing a flake blank or even an early stage preform requires a few minutes at most, and if this work was done at the source location, then it would substantially reduce the weight of the material and facilitate transportation. In the case of direct or especially opportunistic procurement, reduction at the source would be expected because incentives for inefficient transportation of the material would not exist. On the other hand, if the value of obsidian was based on the amount present, then traders who brought the material to the Phoenix Basin would profit from transporting as large of a quantity as possible, and reduction at the source would therefore reduce the value, and in this case inefficient transportation would be expected.

It is also important to consider the fact that obsidian points are small portions of complex systems (including the arrow, bow, and archer) that must be tuned to effectively function (Cotterell and Kamminga 1992:180-188; Loendorf et al. 2019a). Therefore, it is unlikely that completed projectile points or arrows were regularly exchanged, and instead it is more probable that raw materials necessary for point manufacture were traded. Points must be the correct size for projectile shafts, which in turn need be the proper draw length and stiffness for a given bow and archer. Moreover, arrows of different masses will have different points of impact when fired from the same bow, and without some form of standardization in the manufacturing process, projectiles will be inaccurate

(Mason 1894:660). Consequently, customized arrows of consistent sizes were carefully produced to match the body size of individuals, and arrows or points are not freely interchangeable among bows or archers (Burns 1916; Rea 2007; Russell 1908:96).

While rare, occasionally finished projectile points are found of obsidian types that are not present in the associated debitage assemblage. In these cases, some researchers have suggested that this is evidence for trade (Bayman 1995; Bayman and Shackley 1999). However, it is also possible that these points were deposited as the result of conflict, on the end of arrows shot by the enemy. In addition, flaked stone points were also occasionally used in ceremonies or other non-

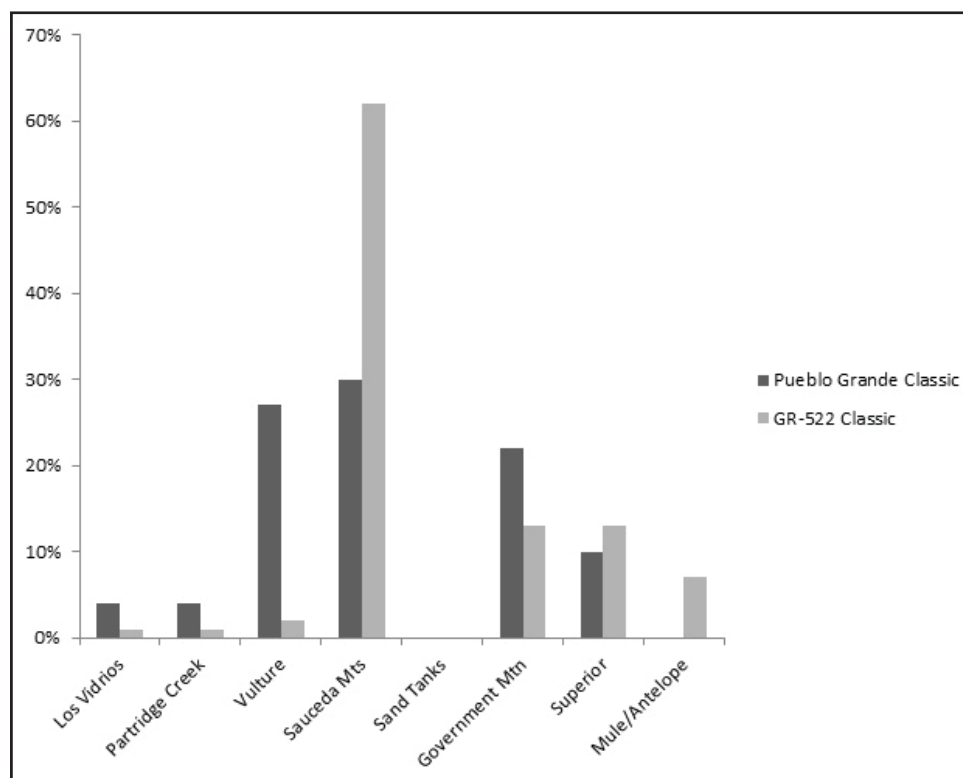


Figure 6. Obsidian source proportions at Pueblo Grande (AZ U:9:1[ASM]) and Lower Santan (GR-522 [GRIC-CRMP]).

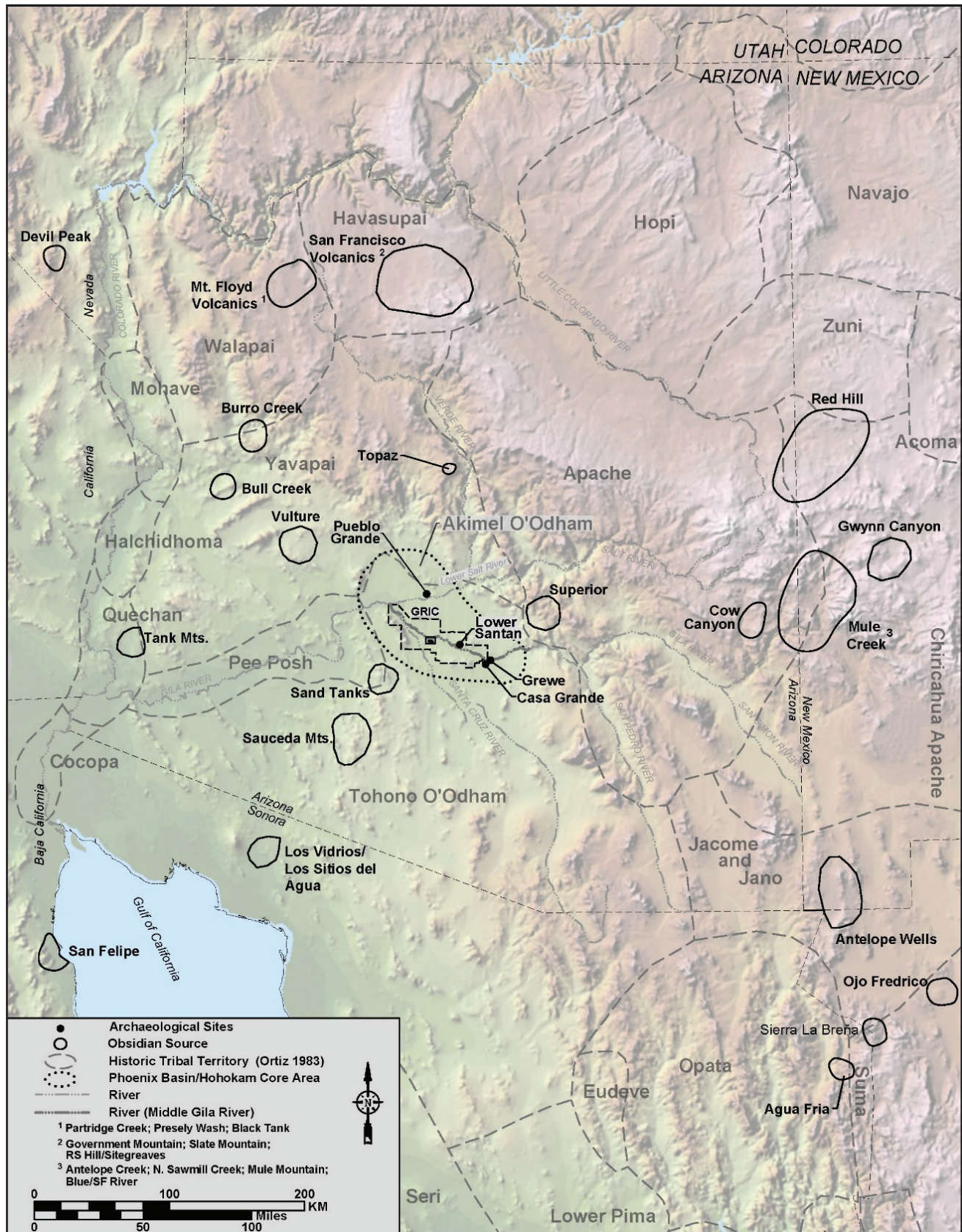


Figure 7. Historic period Native American territories, obsidian source locations, and archaeological sites discussed in the text.



mundane ways (Loendorf 2012; Sedig 2014; Shackley 2005). Points may also have been collected from earlier site components and reused, but temporal patterning in obsidian source data suggests this was not a common acquisition method (Loendorf et al. 2013; Shackley 2005). In any case, data demonstrate that none of these mechanisms were primary sources for points at archaeological sites in the Phoenix Basin, and the vast majority instead appear to have been made by basin residents using raw materials that were imported through trade.

Additional evidence that most of the obsidian arrived through trade is provided by the observation that although most sources that are near the Phoenix Basin were commonly employed, some of the comparatively nearby materials were only rarely used. Sand Tanks obsidian, in particular, is one of the nearest sources but it rarely occurs at prehistoric sites, although it appears to have been somewhat more commonly used during the Historic period (Loendorf et al. 2013; Shackley and Tucker 2001). The Sand Tanks source is located within territory that was occupied by the Hia C'ed O'odham (i.e., Sand Papago) during the Historic period. In contrast to other O'odham (i.e., Pima or Papago) populations who were closely allied with one another, the Hia C'ed O'odham were antagonistic toward other O'odham groups (Hayden 1967:342). This conflict may account for the low incidence of the Sand Tanks obsidian in the Phoenix Basin, which again supports the observation that most of the obsidian arrived through trade with allies.

Temporal patterning in obsidian use also supports the theory that obsidian was largely acquired through exchange relationships. One consistent temporal trend is that the use of Superior obsidian appears to have nearly ceased or at least declined substantially during the late Classic period, and this was one of the most common obsidian types used prior to this time (Shackley 2005). This pattern is clearly illustrated in data from the pre-Classic site of Grewe, which is immediately adjacent to the Classic period site of Casa Grande including AZ AA:2:14 (ASM), AZ AA:2:5 (ASM), AZ AA:2:22 (ASM), and AZ AA:2:3 (ASM; Figure 8; Loendorf et al. 2019b; Shackley 2005). Data from Lower Santan, which is only roughly 30 km to the northwest of Grewe and Casa Grande, are also included for reference (see Figure 7). Similar declines in Superior obsidian occurred at both Lower Santan and at Grewe/Casa Grande. Furthermore, and as is the case for Pueblo Grande, these obsidian collections are more divergent than would be expected based on their spatial proximity alone. Because the location of the source did not change and abundant obsidian remains there today, the observed temporal patterning suggests cultural factors must have affected the use of it. For example, as was the case during the Historic period, it is possible that hunters and gatherers lived in the source region and restricted access during the late Classic period (Loendorf et al. 2013).

By the Late Classic (ca. AD 1320–1450), obsidian frequencies differ significantly between some adjacent areas, such as the Tonto and Salt River arms of the Tonto Basin, suggesting that different Hohokam communities maintained separate trade contacts during this time (Loendorf 2012; Rice et al. 1998; Simon and Gosser 2001). This variation suggests that Late Classic populations were not closely economically integrated across the Hohokam region of southern Arizona (Simon and Gosser 2001). Obsidian acquisition patterns, instead, suggest that the strongest socioeconomic ties among Classic period communities were between sites on the same streams (Loendorf 2012:113). Cooperation among communities that are dependent on the same water sources is expected because episodes of low stream flows are likely to cause conflicts to arise among upstream and downstream water users (Rice 1998). One way to avoid disagreements that result from disputes over limited resources is to develop social institutions that mitigate these stresses. For example, regular social activities such as gatherings for important ceremonies can be used to bring people from different communities together through communal involvement in rituals (Abbott et al. 2007). These events also create opportunities for social and economic interactions among communities, and exchanging food for other items provides a mechanism for redistributing water-dependent resources, which further ameliorates stresses caused by water shortages.

Finally, in contrast to many Native Americans, the Akimel O'odham did not adopt metal points, and they continued using flaked-stone arrow points in warfare until the late 1800s (Loendorf 2012, 2014). Consequently, it is possible to directly compare trends in prehistoric acquisition patterns to those of the historic period (Figure 9; Loendorf et al. 2013). Although the use of obsidian sources to the north and east had largely ended by the Historic period, the employment of obsidian sources to the west, including Vulture obsidian, continued. During most of the Historic period closely allied Pee Posh (i.e., Maricopa) groups lived to the west; however, these people immigrated to the middle Gila during the late Historic period, and afterward acquisition declined of obsidian sources that are located to the west of the Phoenix Basin (Loendorf et al. 2013). By the late Historic period, Sauceda obsidian, which is located to the south in the territory of closely allied Tohono O'odham (i.e., Papago), became the most common obsidian source for the Akimel O'odham (Loendorf et al. 2013). These observations are part of the evidence that suggests obsidian was primarily acquired through trade rather than through direct procurement. Obsidian acquisition patterns also show that long-term trends in cultural patterns within the Phoenix Basin continued unbroken into the Historic period (Loendorf et al. 2013). This continuity provides another line of evidence that the Akimel O'odham are the direct descendants of the Phoenix Basin Hohokam (Loendorf and Lewis 2017).



## CONCLUSIONS

Experimental research demonstrates that low impact strength stones such as obsidian have slightly better performance when penetrating elastic targets, but they are significantly less durable, which limits the potential uses of these comparatively fragile materials. Instead of simply being the highest quality flaked-stone raw material, the low impact strength of obsidian limits the usefulness of this material, and in the Phoenix Basin this stone was almost exclusively used to make small arrow points, many of which were designed for use in conflict. The use of obsidian to manufacture weapons used in warfare is expected to have affected exchange patterns for the material, and it appears to have usually been traded with closely allied peoples.

In general, obsidian source proportions at archaeological sites in the Phoenix Basin are weakly correlated with distance, which suggests that social conditions both impeded and facilitated the movement of goods. At the same time, regional variation in obsidian acquisition suggests that the prehistoric and Historic period populations within Southern Arizona were not politically centralized or economically integrated. Differences in obsidian acquisition patterns among immediately adjacent areas increase during the Classic period, and conflict appears to have intensified over time. In general, these data show that the occurrence of obsidian types which are located in the territories of historical enemies of the

Akimel O'Odham decline over time. Finally, these trends in obsidian acquisition patterns that begin in prehistory continue unbroken into the Historic period, and by the late 1800s the Akimel O'Odham largely obtained obsidian from the Saucedo Mountains, which is one of the few sources still located in the territory of a closely allied people (i.e., the Tohono O'Odham).

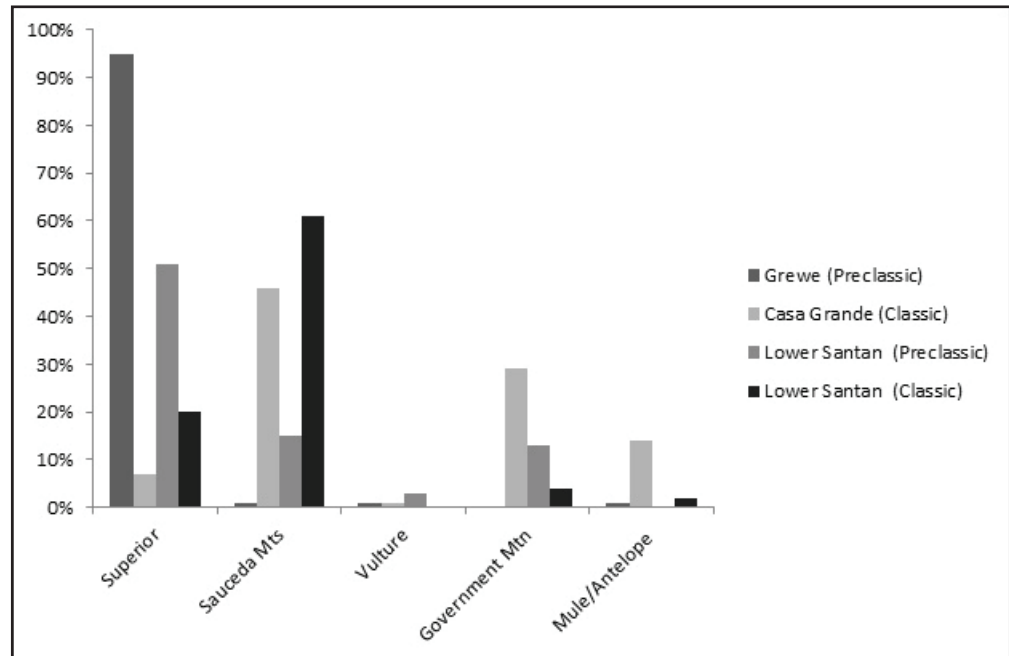


Figure 8. Obsidian source proportions at Grewe (AZ AA:2:2[ASM]), Casa Grande (AZ AA:2:14 [ASM], AZ AA:2:5 [ASM], AZ AA:2:22 [ASM], and AZ AA:2:3[ASM]), and Lower Santan (GR-522 [GRIC-CRMP]).

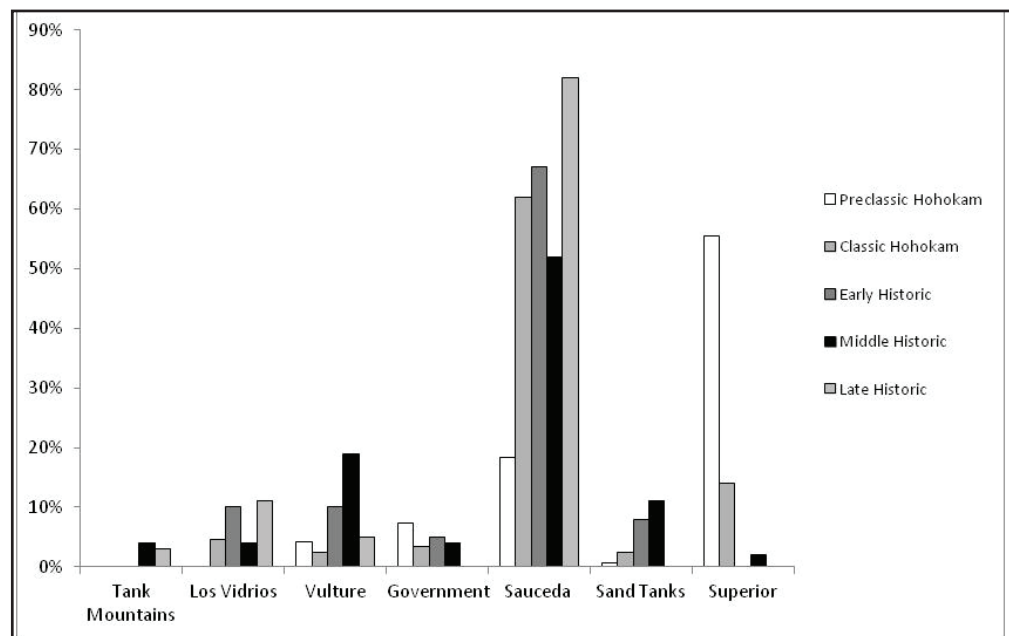


Figure 9. Pre-Classical, Classical, and Historic period obsidian frequencies over time along the middle Gila River (adapted from Loendorf et al. 2013).

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# FROM WATER TO LAND: HOHOKAM PRESENCE AND INFLUENCE AT WUPATKI PUEBLO THROUGH SHELL ARTIFACTS

Alexandra Covert

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*This article examines prehistoric shell artifacts from Ancestral Puebloan, Sinagua, and Hohokam sites. Shell artifacts are indicators of trade relationships between different cultural groups. Therefore, shells found at Ancestral Puebloan and Sinagua sites shed light on the trade relationships between the Ancestral Puebloans, Sinagua, and Hohokam. By looking at shell assemblages from one Ancestral Puebloan site: Wupatki Pueblo; three Sinagua sites: Elden Pueblo, Winona Village, and Ridge Ruin; and two Hohokam sites: Pueblo Grande and La Plaza, this paper attempts to determine Hohokam influence on Ancestral Puebloan and Sinagua sites. Specifically, shell from Wupatki Pueblo was analyzed for Hohokam style traits in order to determine if the Hohokam traded or brought shell artifacts to Wupatki Pueblo as finished products or if shell manufacturing occurred at Wupatki Pueblo. Ultimately, this research adds valuable information about trade, migration, and social networks between the Hohokam, Sinagua, and Ancestral Puebloans, which is important to understanding function, complexity, ideology, adaptation, resilience, and the foundation of modern Pueblo cultures.*

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This article aims to place the shell artifacts from Wupatki Pueblo, a Pueblo II to Pueblo III Ancestral Puebloan site, in the context of Southwestern shell manufacturing and distribution. The Wupatki Pueblo shell assemblage was analyzed against shell artifact production and distribution from three Sinagua sites and two Hohokam sites. This analysis was conducted to examine whether the Hohokam influenced Ancestral Puebloans and the Sinagua through migration, down-the-line trade, or Hohokam traders.

## HOHOKAM PRESENCE AND INFLUENCE ON ANCESTRAL PUEBLOANS AND THE SINAGUA

The presence and influence of the Hohokam at northern Arizona archaeological sites may be seen through migration and trade.

## Migration

Since the 1920s, archaeologists have debated the presence and influence of the Hohokam on Ancestral Puebloans and the Sinagua. Much research focused on Ancestral Puebloan and Sinagua sites with Hohokam traits after the eruption of Sunset Crater Volcano in AD 1064. For example, there is a high frequency of Hohokam traits such as cremation burials, ballcourts, trash mounds, architecture, and traded goods, such as spindle whorls, ceramic figurines, Gila-shouldered jars, red-on-buff pottery, and shell ornaments found at these sites (Murphy 2000). These artifacts and traits indicate influence from the Hohokam, most likely due to migration by the Hohokam to northern Arizona (Colton 1918, 1936, 1960; McGregor 1937a, 1937b).

Early researchers on Hohokam migration to northern Arizona include Lyndon L. Hargrave, Katherine Bartlett, Harold Colton, and John McGregor. All these researchers are associated with the Museum of Northern Arizona (MNA). Michael Stanislawski, a graduate student attending Arizona State University (ASU) in the 1960s, also conducted research on Hohokam migration to northern Arizona. Hargrave and Bartlett determined that there was a strong presence and influence of the Hohokam at the site of Turkey Tanks (NA 2098) (Bartlett 1934; Hargrave 1932). Bartlett (1934) attributed these Hohokam characteristics to Hohokam migration to northern Arizona. Colton created the “black sand hypothesis” which stated that the eruption of Sunset Crater Volcano allowed for better agricultural conditions and therefore attracted other people to migrate to northern Arizona, such as the Hohokam (Colton 1936, 1946, 1960). McGregor agreed with Colton and thought that the eruption of Sunset Crater Volcano attracted migrant populations (McGregor 1941). Additionally, Stanislawski agreed with Colton and McGregor and believed that the Sinagua were a homogenous culture before the

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eruption of Sunset Crater Volcano. After the eruption, various people from different regions, such as Mogollon, Chaco Canyon, and Hohokam, migrated to northern Arizona and led to the cultural blending of the Sinagua (Stanislawski 1963).

Archaeologists (Downum 1988; Fish et al. 1980; Hevly et al. 1979; Kelly 1971; Pilles 1978, 1979) have challenged Colton's "black sand hypothesis." John P. Wilson (1969) proposed that the cause of the influx of migrants from the surrounding culture areas was not due to the increase in agricultural conditions from the eruption of Sunset Crater Volcano, but rather was due to an increase in population in these cultures. Additionally, Pilles (1978, 1979) and Fish et al. (1980) agreed with Wilson's criticisms of the "black sand hypothesis." Pilles (1978, 1979) does not agree with the idea that prehistoric migrants moved to northern Arizona due to an increase in agricultural productivity from the eruption of Sunset Crater Volcano. Instead, an increase in rainfall and warmer temperatures rather than volcanic mulch increased population. Pilles (1979) also states that the increase in population seen in the Sinagua after the eruption of Sunset Crater Volcano can also be seen throughout the Southwest at the same time. Therefore, the increase in population is not just unique to the Sinagua (Pilles 1979).

Many archaeologists, such as Fish et al. (1980), question the idea that Hohokam migration to northern Arizona ever happened. Instead, they propose that Hohokam influence and presence in northern Arizona is a result of trade relations and Hohokam traders co-living at large Ancestral Puebloan and Sinagua sites. Murphy (2000) agrees with this and states that it is likely that Hohokam people were co-residents at Sinagua sites, specifically at Winona Village and Ridge Ruin.

### Trade

McGuire and Downum (1982) applied a down-the-line model to examine prehistoric north/south trade networks to help explain shell found at Sinagua sites and Kayenta branch black-on-white ceramics found at Hohokam sites. Jernigan (1978) discussed the near absence of shell ornaments at Ancestral Puebloan sites, which contrasts with Hohokam sites where there is a high presence of shell ornaments. Jernigan (1978) thinks this is due to indirect trade between the Hohokam and Ancestral Puebloans rather than through direct trade. Jernigan (1978) proposes that the Hohokam traded with the Mogollon who then traded with the Ancestral Puebloans. An analysis of the shell artifacts recovered from excavations at Wupatki Pueblo revealed that shell artifacts at Wupatki Pueblo originated from the Gulf of California, coast of California, and Gulf of Mexico. A high quantity of worked shell indicates trade from the Hohokam to the residents of Wupatki Pueblo (Stanislawski 1963). Mills and Ferguson (2008) indicated that the presence of shell trumpets at northern Arizona sites

allowed for the identification of social networks related to ritual practices.

Additionally, archaeologists can see the influence of the Hohokam through ballcourts at Sinagua and Ancestral Puebloan sites. Wilcox (1993) and Fish et al. (1980) support the idea that Hohokam style ballcourts at northern Arizona sites were perhaps redistribution centers and therefore allowed for trade and exchange to transpire between the Sinagua, Ancestral Puebloans, and the Mogollon. Murphy (2000) and Hedquist (2012) determined that exotic goods in Sinagua and Ancestral Puebloan sites were more likely to be found at sites with large ceremonial structures such as kivas, ballcourts, and plazas.

After the eruption of Sunset Crater Volcano, there was a dramatic shift in Sinagua communities as evidenced by the construction and use of Hohokam ballcourts. The construction and use of Hohokam ballcourts not only allowed for public ritual, but also allowed for an integration of the region through interaction networks and long-distance exchange (Gruner 2012). The influence of the Hohokam on the Sinagua could be evidence of ritual pilgrimages by the Hohokam to the Sinagua area to see volcanic activity (Lekson 2008; Whittaker and Kamp 1992). O'Hara (1998) examined Hohokam style red-on-buff ceramics at northern Arizona sites and determined that the ceramics were manufactured by Sinagua people who were attempting to create social connections with Hohokam trading partners, the Southern Sinagua introduced these ceramics to the Northern Sinagua, or a Hohokam trader could have lived at Winona Village.

### IMPORTANCE OF SHELL

Shell was important to prehistoric peoples because it showed power, esteem, and security through wealth. Shell jewelry was a physical sign of wealth. By wearing shell jewelry as an individual, wealth was visible to all other members of society (Jernigan 1978).

Shell artifacts indicate the degree of Hohokam presence and influence at Ancestral Puebloan and Sinagua sites. Shell artifacts were used as adornment and showed prestige, wealth, and authority. Shell adornment could have signified a person's ethnicity, social status, or membership in a religious or social group (Hedquist 2012). This can be seen through Glycymeris bracelets which are signifiers of being Hohokam (Bayman 2002). Shell bracelets are more common at Ancestral Puebloan and Sinagua sites during the time Hohokam style ballcourts were used and are found concentrated at sites with ballcourts (Murphy 2000; Hedquist 2012). This shows an influence and presence of the Hohokam based on shell bracelets in relation to ballcourts.

The importance of shell can also be seen in modern day Native American tribes. Lyle Balenquah (2013), a member of the Hopi tribe, states that marine shell



has many symbolic traits. Shell tinklers were tied together and worn to make noise. Since water is scarce in the Southwest, the sound of shells rattling together is a way to summon rain. The sound of shells rattling together is also a metaphorical connection to wanting or needing water. Shells carved into frogs also indicate the importance of the connection to water (Balenquah 2013). Prehistoric peoples often used *Strombus* shells as trumpets to summon horned serpents that lived in water and controlled snow, rain, and the flow of water (Hedquist 2012).

### SIGNIFICANCE OF PREHISTORIC SHELL TRADE

Trade and exchange are important research issues in the prehistoric Southwest because they show the importance of relationships with other cultures (Figure 1). Shell is seen as an exotic resource in the Southwest because shells were difficult to acquire since they origi-

nated from hundreds of miles away (Hedquist 2012). Prehistoric shell trade often follows a distance-decay model. Typically, people exchange non-prestige utilitarian items within a short distance of their villages and obtain prestige goods, such as shell, from different prehistoric groups spanning hundreds of miles (Bayman 1999). Therefore, generally the farther north an archaeological site is in the Southwest, the less abundant shell is (Vokes 1999). The large quantity of shell at Wupatki Pueblo is significant because it shows that extensive trade networks and trade relationships must have existed in order for the Ancestral Puebloans to acquire such a large quantity of shell objects.

Trade is also important to social networks. Social networks in the Southwest transformed across spatial, temporal, and social scales. Social distance does not always correlate with spatial distance because the presence of network relationships spans long geographic distances. Spatial proximity predicts social connectedness based on material culture from archaeological

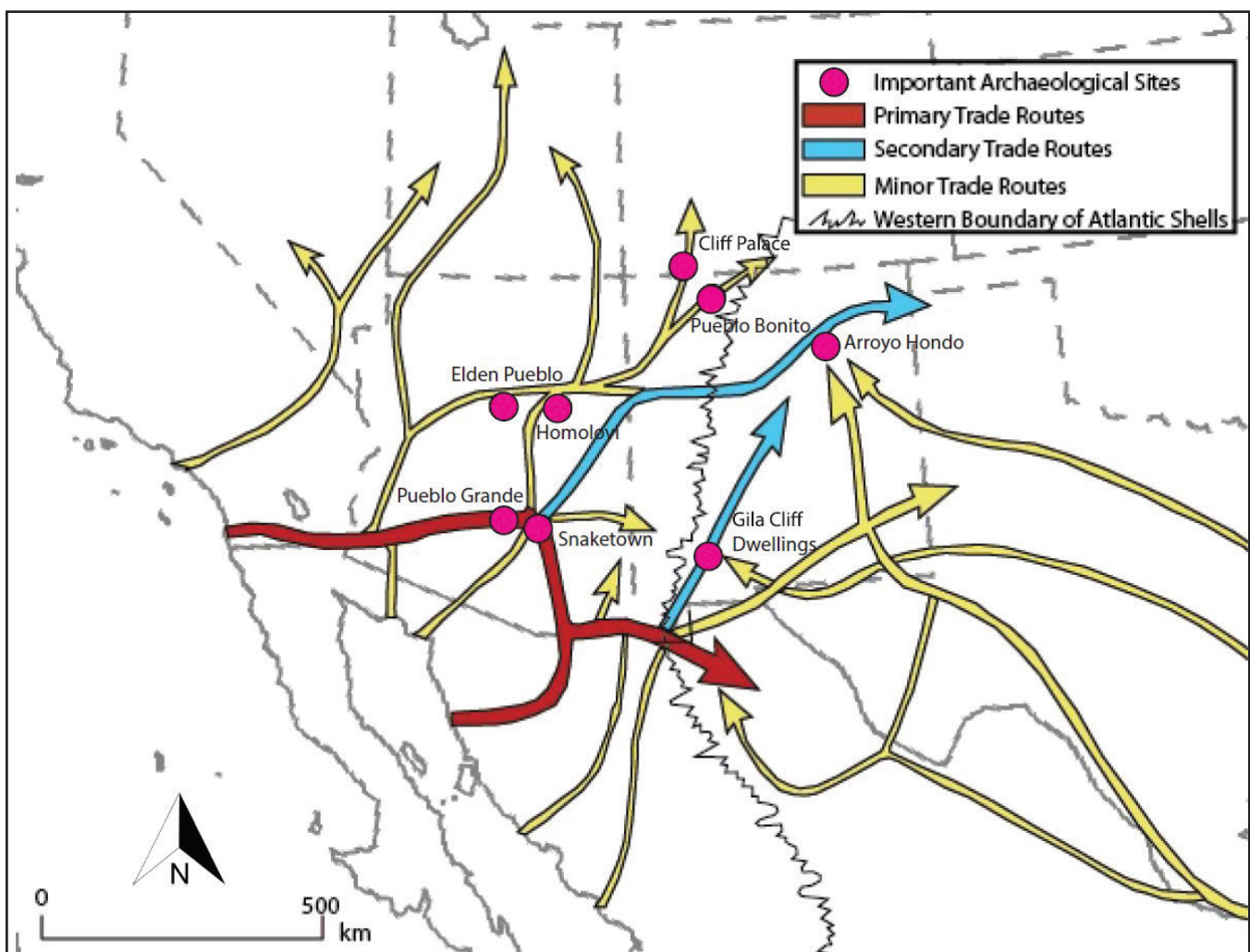


Figure 1. Prehistoric trade routes of shell from the Gulf of California, coast of California, and Gulf of Mexico to the Southwest (Adapted from Brand 1938; Schinsing 2012).

sites. Most social interaction, including the movement of goods, took place within a day's round trip walk from home, thus archaeologists anticipate that sites would have stronger social connections to proximate sites (Mills et al. 2012). The exchange of shell in social networks adds prestige to individuals who acquire, display, and control these objects (Trubitt 2003). The exchange of shell in social networks in turn causes shell to be seen as a prestige good and, therefore, materializes the political, social, and economic relationships between people at local and regional scales (DeMarrais et al. 1996).

## OBJECTIVES

In this study, I aimed to address three objectives based on the analysis of the shell assemblage from Wupatki Pueblo. First, I examined where the shell artifacts were being produced and who produced them. Second, I examined whether the shell came to Wupatki Pueblo as a result of down-the-line trade, transportation by traders, or migration. Finally, I examined how the shell assemblage from Wupatki Pueblo compares to the shell assemblages from three Sinagua sites and two Hohokam sites.

## METHODS

The methods used for my research are identification and comparison. These methods allowed for a better understanding of the relationship between the Hohokam and Wupatki Pueblo based on shell artifacts. These methods allowed me to determine the shell genus and artifact types; compare shell assemblages between Ancestral Puebloan, Sinagua, and Hohokam sites; and determine the significance of shell at Wupatki Pueblo.

### Shell Identification

Shell identification determined shell genus and species, artifact type, and whether the artifacts were Hohokam in style. I recorded the species of the shell when possible. I photographed each shell genus and artifact type. Artifacts that had previously been analyzed were reanalyzed.

Shell genus and species identification was possible with several sources and guides including Dr. Christian E. Downum's comparative shell collection, *A Guide to Field Identification: Seashells of North America* (Abbott 1986), and *A Field Guide to Shells: Atlantic and Gulf Coasts and the West Indies* (Abbott and Morris 1995). If shell genus and species identification could not be determined, artifact photographs were sent to Arthur Vokes and Erika Heacock at the Arizona State Museum Archaeological Repository in Tucson, Arizona in order to make the genus and species identification. Additionally, if a determination was not possible, the artifacts were classified as unidentifiable.

I also analyzed the shell to identify Hohokam style artifacts by referencing *Hohokam Marine Shell Exchange and Artifacts* (Nelson 1991) and *Jewelry of the Prehistoric Southwest* (Jernigan 1978) in order to determine if the Hohokam manufactured the shell objects and traded the objects to Wupatki Pueblo or if the people of Wupatki Pueblo manufactured shell objects. Additionally, there was the possibility of finding shell debitage present in the assemblage. If shell debitage was present in the assemblage, it would allow for determining if shell manufacturing occurred at Wupatki Pueblo. No shell debitage was recorded or located in the Wupatki Pueblo shell assemblage.

### Comparative Data

I compared the shell assemblage from Wupatki Pueblo to the shell assemblages of three other northern Arizona archaeological sites (Table 1): Winona Village (Murphy 2000), Ridge Ruin (Murphy 2000), and Elden Pueblo. The comparison between the shell assemblage from Wupatki Pueblo and the shell assemblages from Winona Village, Ridge Ruin, and Elden Pueblo was undertaken to determine the similarities and differences between northern Arizona archaeological sites regarding artifact types and shell genera (Tables 2 and 3).

I also compared the shell assemblage from Wupatki Pueblo to Pueblo Grande and La Plaza which are Hohokam sites. Occupation at Pueblo Grande occurred from AD 500 to AD 1450 with the peak of its occupation during the Classic period between AD 1150 and AD 1450 (Andrews and Bostwick 2000). Occupation of La Plaza occurred from AD 775 to AD 1300, during the Colonial, Sedentary, and Classic periods. The Ancestral Puebloan and Sinagua sites in this paper correspond with the Hohokam Sedentary (AD 950 to 1100) and Classic (AD 1100

**Table 1. Comparison of shell artifacts and genera between sites used for this analysis.**

Site	Number of Shell Artifacts	Number of Shell Genera	Number of Shell Artifact Types
Ancestral Pueblo			
Wupatki Pueblo	1,844	22	13
<i>Subtotal</i>	<i>1,844</i>	<i>22</i>	<i>13</i>
Sinagua			
Elden Pueblo	1,308	21	14
Ridge Ruin Complex	237	9	11
Winona Village	526	14	11
<i>Subtotal</i>	<i>2,071</i>	<i>26</i>	<i>17</i>
Hohokam			
La Plaza	2,254	18	7
Pueblo Grande	9,099	15	9
<i>Subtotal</i>	<i>11,353</i>	<i>24</i>	<i>12</i>

**Table 2. Shell genera by culture.**

Wupatki Pueblo	Sinagua	Hohokam
<i>Aequipecten</i>	<i>Anodonta</i>	<i>Anodonta</i>
<i>Anodonta</i>	<i>Argopecten</i>	<i>Argopecten</i>
<i>Cardium</i>	<i>Chione</i>	<i>Cardiidae</i>
<i>Clima</i>	<i>Chione/Glycymeris</i>	<i>Cerithidea</i>
<i>Conus</i>	<i>Conus</i>	<i>Columbella</i>
<i>Cowry</i>	<i>Cardium</i>	<i>Conus</i>
<i>Dentalium</i>	<i>Cerithidea</i>	<i>Glycymeris</i>
<i>Glycymeris</i>	<i>Cockle</i>	<i>Haliotis</i>
<i>Haliotis</i>	<i>Dentalium</i>	<i>Helisoma</i>
<i>Laevicardium</i>	<i>Glycymeris</i>	<i>Laevicardium</i>
<i>Murex</i>	<i>Haliotis</i>	<i>Muricanthus</i>
<i>Nassarius</i>	<i>Laevicardium</i>	<i>Nassarius</i>
<i>Naticidae</i>	<i>Nassarium</i>	<i>Oliva</i>
<i>Neritina</i>	<i>Nerita</i>	<i>Olivella</i>
<i>Olivella</i>	<i>Oliva</i>	<i>Pecten</i>
<i>Oreohelix</i>	<i>Olivella</i>	<i>Pecten/Argopecten</i>
<i>Pecten</i>	<i>Oreohelix</i>	<i>Pectinidae</i>
<i>Polinices</i>	<i>Ostrea</i>	<i>Physa</i>
<i>Spondylus</i>	<i>Pecten</i>	<i>Pisidium</i>
<i>Spondylus/Chama</i>	<i>Pyrene</i>	<i>Pyrene</i>
<i>Strombus</i>	<i>Rumina</i>	<i>Spondylus</i>
<i>Turritella</i>	<i>Spondylus</i>	<i>Spondylus/Chama</i>
	<i>Spondylus/Chama</i>	<i>Trachycardium</i>
	<i>Turritella</i>	<i>Turritella</i>
	<i>Trachycardium</i>	
	<i>Trivia</i>	

to 1450) periods and therefore are contemporaneous with Pueblo Grande and La Plaza.

The comparison between the shell assemblage from Wupatki Pueblo and the shell assemblage from the Hohokam sites was conducted to determine the similarities and differences regarding artifact types and shell genus and species. Additionally, the comparison was conducted to determine if shell artifacts with similar styles and designs found at Pueblo Grande and La Plaza were found at Wupatki Pueblo. This would suggest trade of completed manufactured shell objects from the Hohokam to the people of Wupatki Pueblo or the migration of Hohokam people to Wupatki Pueblo.

## SITES

Six archaeological sites were used in this study: Wupatki Pueblo, Elden Pueblo, Winona Village, Ridge Ruin, Pueblo Grande, and La Plaza (Figure 2). The sites in this research, respectively, consist of one Ancestral

Puebloan site, three Sinagua sites, and two Hohokam sites. Wupatki Pueblo was chosen as the main site to be analyzed because it is one of the largest sites in the Flagstaff area and contains Ancestral Puebloan, Sinagua, Hohokam, and Chacoan attributes (Wilcox 1993) as well as a large shell assemblage. Elden Pueblo, Winona Village, and Ridge Ruin were selected because they are all large Flagstaff area sites that are contemporaneous with Wupatki Pueblo and have significant shell assemblages that have been recently analyzed. Therefore, they are useful sites to analyze for local comparisons. Pueblo Grande and La Plaza were selected because they are significant Hohokam habitations that contain large shell assemblages and are also contemporaneous with Wupatki Pueblo and the three Sinagua sites.

## Wupatki Pueblo

Wupatki Pueblo (NA 405) is a Pueblo II to Pueblo III site located in northern Arizona, approximately 45 miles from Flagstaff, Arizona (Figure 3). The site contains 100 rooms with an associated Hohokam style ballcourt (O'Hara 2012), blowhole, and community room (Downum 2004). Wupatki Pueblo is built along a sandstone ledge and would have stood at least three stories tall. It consists of at least 70 ground floor rooms and 30 upper floor rooms. Wupatki Pueblo would have had a population of about 120 people (Stanislawski 1963). Wupatki Pueblo was the region's largest and tallest town. It was a trading center, gathering place, landmark, place of sa-

**Table 3. Artifact types by culture.**

Wupatki Pueblo	Sinagua	Hohokam
Bead	Bead	Awl
Bracelet	Bead/Pendant	Bead
Disc	Bracelet	Bracelet
Figurine	Bracelet/Pendant	Cut shell figurine
Mosaic	Debitage	Debitage
Needle	Fossil	Needle
Ornament	Inlay	Pendant
Pendant	Pendant	Ring
Ring	Pendant/Ring	Ring/earring/pendant
Tinkler	Reworked shell	Tinkler
Trumpet	Ring	Unworked shell
Unworked shell	Tesserae	Zoomorph
Worked shell	Tinkler	
	Utility	
	Worked shell	
	Unworked shell	
	Unknown artifact type	



cred ceremony and ritual, and a treasury of exotic goods (Downum et al. 2012). Ancestral Puebloans occupied Wupatki Pueblo from around AD 1137 to AD 1250 (Burchett 1990; Pilles 1996), yet occupation of the Wupatki Basin occurred as early as AD 550. Wupatki Pueblo witnessed a population boom in the early 1100s and abandonment occurred in the late 1200s (Downum 2004).

Shell from Wupatki Pueblo is housed at MNA, Wupatki National Monument, and the Western Archaeological and Conservation Center (WACC). Shell from the first two institutions was analyzed by the author and the shell artifacts at WACC were previously analyzed

by WACC staff. The shell data set for Wupatki Pueblo contains information regarding catalog number, artifact type, completeness, measurements, provenience, description, condition, Hohokam style artifacts, shell count, and shell genus and species. The shell assemblage from Wupatki Pueblo consists of 1,844 artifacts.

### Elden Pueblo

Elden Pueblo (NA 142) is a Rio de Flag, Padre, and Elden Phase Sinagua site located approximately seven miles north of Flagstaff, Arizona (Figure 4). Elden Pueblo dates from AD 1070 to AD 1275. Elden Pueblo is a



Figure 2. Map of site locations for sites used in this study.





**Figure 3. Wupatki Pueblo South Unit, North Unit, amphitheater, and ballcourt, view to the northwest (Image by author 2017).**

65 room, two-story tall pueblo with associated trash mounds, smaller pueblos, a community room, a kiva, and pithouses. Occupation of Elden Pueblo took place after the eruption of Sunset Crater Volcano, which is located just 10 miles east. By AD 1100, the Sinagua at Elden Pueblo started to build stone-lined pithouses, pueblos, and masonry structures (Pilles 2009). The pueblos consist of two to three rooms with each room housing a single family. These pueblos later became the center of Elden Pueblo.

By AD 1150, Elden Pueblo was an important trade center. The people of Elden Pueblo made plainware pottery, woven cotton textiles, and obsidian projectile points. These were traded with other cultures

for shell jewelry, turquoise, mineral pigments, argillite, painted ceramics, nose plugs, bird effigy vessels, carved bone hair pins, macaws, and copper bells (Pilles 2009). The presence of rare artifacts such as bird effigy vessels, bone hair pins, nose plugs, and turquoise mosaics in the shape of frogs and birds in flight suggests that Elden Pueblo was a hierarchical society (Pilles 2009).

Around AD 1250, many people moved to Elden Pueblo because of a drought in the region. A large community room was built in place of the kiva. Continued drought and cooler temperatures did not allow for agriculture and therefore abandonment of Elden Pueblo occurred by AD 1275 (Pilles 2009).



**Figure 4. Overview of a roomblock of Elden Pueblo, view to the northeast (Image by author 2017).**



Coconino National Forest staff analyzed 1,308 shell artifacts from Elden Pueblo. The shell data set for Elden Pueblo contains information regarding catalog number, artifact type, completeness, measurements, provenience, description, condition, shell count, and shell genus and species.

### Winona Village

Winona Village (NA2131, NA2132, NA2133, NA2134, NA2135, and NA3644) is a Padre Phase Sinagua site complex dating from AD 1075 to AD 1125 and is located approximately 17 miles northeast of Flagstaff, Arizona near the town of Winona (Figure 5).

Winona Village consists of a large pithouse village with five main clusters of pithouses, small surface structures, trash mounds, and a ballcourt (McGregor 1937a, 1937b). When John C. McGregor recorded the site in 1935, he identified each cluster as an individual site. McGregor, with the help of MNA and the Arizona State Teachers College (now known as Northern Arizona University), excavated the Winona Village ballcourt and other features in the area. In 1935, archaeologists trenched the ballcourt walls, tested the center, and completely cleaned the ballcourt. The ballcourt was fully excavated from 1936 to 1937 and was determined to be Hohokam in style. The Works Progress Administra-

tion conducted additional excavations at Winona Village in 1938 and 1939 using the same excavation techniques as McGregor (Murphy 2000). The additional excavations showed additional Hohokam influence at Winona Village through a pithouse with Hohokam style architecture, red-on-buff ceramics, cremation burials, and shell ornaments (O'Hara 2012).

This research focuses on six sites from the Winona Village site complex: NA2131, NA2132, NA2133, NA2134, NA2135, and NA3644. NA2131 consists of one pithouse, a three-room masonry pueblo, and an associated trash mound (McGregor 1941).

NA2132 is the ballcourt at Winona Village. It perhaps served a ritual function or as a trade center (Nelson 1991; Wilcox 1993; Wilcox and Sternberg 1983). No shell was recovered from excavations of the ballcourt, but it is interesting to note due to its Hohokam style.

NA2133 consists of a cluster of sites with known Hohokam traits (Murphy 2000, O'Hara 2012). NA2133A is known as "Hohokam House" because its features are representative of a Sedentary Hohokam pithouse (McGregor 1941; O'Hara 1998). The pithouse is deep with parallel sides, rounded corners, and an alcove on the east side. NA2133A is almost identical to excavated pithouses at Snaketown (AZ U:13:1). This pithouse and a pithouse at Turkey Tanks (NA2098) are the only Sed-



Figure 5. Winona Village pithouse depression, view to the northeast (Image by author 2018).





Figure 6. Ridge Ruin, view to the northwest (Image by author 2018).

entary Hohokam style pithouses found in the Flagstaff region (McGregor 1941). Not only is the architecture Hohokam in style, but also Hohokam style ceramics such as Coconino red-on-buff and Winona red-on-buff were found at NA2133A (McGregor 1941; O'Hara 1998). NA2133B is an excavated surface structure located south of NA2133A. It is associated with NA2133A and did not contain any shell artifacts (Murphy 2000). NA2133C is an excavated pithouse with Hohokam features such as curved corners and a ramped entrance (McGregor 1941). NA2133E is also an excavated pithouse. NA2133T is the trash slope associated with the pithouses of NA2133 (Murphy 2000).

NA2134 consists of two excavated pithouses, a cremation area, and a trenched trash mound (McGregor 1941). NA2135 consists of three excavated pithouses and one tested pit depression (McGregor 1941). Pithouse C shows evidence of burning during occupation (Murphy 2000). NA3644 consists of nine excavated pithouses, one tested pit depression, three trenched trash mounds, and one tested and trenched trash mound (McGregor 1941).

Tracy L. Murphy previously analyzed the shell data set for Winona Village for her Master's thesis *Ornamentation and Social Affinity: Shell Ornaments and the Hohokam Influence at Winona Village* (Murphy 2000) at

Northern Arizona University. The shell data set for Winona Village contains information regarding site, catalog number, artifact type, completeness, provenience, condition, shell count, and shell genus and species. The shell assemblage from Winona Village consists of 526 artifacts.

### Ridge Ruin

Ridge Ruin (NA 3669) is a Padre through Elden phases Sinagua site complex dating from AD 1140 to AD 1170 (O'Hara 2008) and is located approximately 20 miles east of Flagstaff, Arizona on the Coconino National Forest (Figure 6). Ridge Ruin is a masonry pueblo with approximately 20 to 25 rooms. Many of the rooms were two stories tall. The walls were made of sandstone blocks and basalt boulders. Ridge Ruin also consists of a raised platform, rock enclosures, and plazas. Archaeologists discovered an elaborate burial, the Magician's Burial, to the north of the main pueblo in a potential kiva (McGregor 1943). The burial contained over 600 objects including macaw skeletons, painted sticks, ceramics, lithics, painted basketry, shell, animal parts, rare stones, and mineral pigments (Gruner 2012). The Magician's Burial shows how shell adornment was important in distinguishing high-status individuals in the northern Southwest (Table 4; O'Hara 2008, 2015).



I do not specifically discuss Ridge Ruin in this research, but I do discuss four sites in the Ridge Ruin complex: NA1785, NA3673, NA3676, and NA3680. NA1785 is a pueblo of less than 20 rooms (Murphy 2000). NA3673 is a completely excavated pithouse located below a trash mound (Murphy 2000). NA3676 is a tested trash mound and NA3680 is a single tested pithouse covered by a trash slope (Murphy 2000).

Tracy L. Murphy analyzed the shell artifacts from Ridge Ruin (Murphy 2000). The shell data set for Ridge Ruin contains information regarding site, catalog number, artifact type, completeness, provenience, condition, shell count, and shell genus and species. The shell assemblage from Ridge Ruin consists of 237 shell artifacts from four sites.

### Pueblo Grande

Pueblo Grande (AZ U:9:1) is a Pioneer, Colonial, Sedentary, and Classic period Hohokam site (Figure 7). Pueblo Grande dates from around AD 500 to AD 1450 with the peak of its occupation between AD 1150 and AD 1450 (Andrews and Bostwick 2000). Pueblo Grande is located two miles west of the Papago Buttes and on the north side of the Salt River (Andrews and Bostwick 2000) in Phoenix.

**Table 4. Shell artifacts recovered from the Magician's Burial (O'Hara 2008).**

Genus	Artifact Type	Count
<i>Abalone</i>	Earrings	2
<i>Abalone</i>	Pigment stained shell fragments	Unknown
<i>Abalone</i>	Whole shell	1
<i>Cardium</i>	Whole shell	5
<i>Conus</i>	Tinklers	Unknown
<i>Galeodea</i>	Wooden swallowing sword with whole shell on handle	1
<i>Glycymeris</i>	Bird shaped mosaic bracelet	1
<i>Turritella</i>	Pendant	1
Unidentified	Cut-out shell pendants	2
Unidentified	Lizard-shaped pendant	2
Unidentified	Rim of large shell	1
Unidentified	Stone and shell bead cap	100+
Unidentified	Swallowing sword with turquoise and shell mosaic crescent handle	1
Unidentified	Turquoise and shell earrings	Unknown
Unidentified	Turquoise and shell mosaic crescent	1
Unidentified	Turquoise and shell pendant	1



**Figure 7. Pueblo Grande platform mound, view to the northwest (Image courtesy of Selena Soto 2018).**

The initial settlement of Pueblo Grande occurred around AD 500 and is evidenced by a canal system on the southern edge of the site. By AD 750, Pueblo Grande consisted of pithouses, trash mounds, cemeteries, and a ball court. During this time, the canal system expanded to irrigate farmlands. Between AD 900 and AD 1150, a small circular platform mound was built. Between AD 1150 and AD 1405, Pueblo Grande expanded several times. A large platform mound was built, coursed-adobe houses arranged in compounds replaced pithouses, more irrigation canals were built, and a tower-like "Big House" similar to that of Casa Grande Ruins (AZ AA:02:14) was constructed. In AD 1358,

large floods of the Salt River occurred. These floods most likely led to the collapse and restructuring of Pueblo Grande and other sites in the surrounding area. By AD 1450, the Hohokam abandoned Pueblo Grande (Andrews and Bostwick 2000).

The shell data set for Pueblo Grande contains information regarding artifact type, provenience, shell count, and shell genus and species. The shell assemblage from Pueblo Grande consists of 9,099 shell artifacts (Gross and Stone 1994).

### La Plaza

La Plaza (AZ U:9:165) is a Colonial and Sedentary Hohokam site. Occupation of La Plaza occurred from AD 775 to AD 1300. The site also dates to the 1860s through the 1970s, but the historic occupation of La Plaza will not be discussed. La Plaza is located on Eighth Street near Arizona State University's campus in Tempe, Arizona (Wright and Kwiatkowski 2005).

La Plaza encompasses roughly 380 acres. The site consists of tightly clustered habitation features. Seventeen canal segments run through the site. Additionally, there are pits, pithouses, platform mounds, miscellaneous features, and cremations (Kwiatkowski and Wright 2005; Stone 1991; Turney 1929). Excavations first occurred at La Plaza in 1971 in order to salvage prehistoric cultural material located near Sun Devil Stadium (Hanson 1972). More recent excavations occurred at La

Plaza from 2005 to 2007 by Archaeological Consulting Services, Ltd. for the Central Phoenix/East Valley Light Rail Transit Project (Schilz et al. 2011).

Andrea Gregory and Glennda Gene Luhnnow analyzed the shell assemblage from La Plaza (Gregory 2011). The shell data set for La Plaza contains information regarding artifact type, completeness, provenience, condition, shell count, and shell genus and species. The shell assemblage from La Plaza consists of 2,254 shell artifacts.

### WUPATKI PUEBLO RESULTS

Wupatki Pueblo has a total of 1,844 shell artifacts consisting of 22 different genera and 13 different artifact types (Figure 8). The completeness of the objects ranges from fragmented to whole. Wupatki Pueblo has evidence of burnt, smoothed, polished, incised, and re-worked shell. Within the site, archaeologists found shell artifacts in rooms, trenches, trash mounds, retaining walls, room trash, on the surface, in the amphitheater, and in the ballcourt.

The presence of Hohokam influence or Hohokam style in the Wupatki Pueblo shell assemblage is seen through Hohokam style artifacts. Out of 1,844 shell artifacts, 1,115 are Hohokam in style. Of the remaining 729 artifacts, 250 do not exhibit Hohokam style or design and 479 are indeterminate. Therefore, approximately

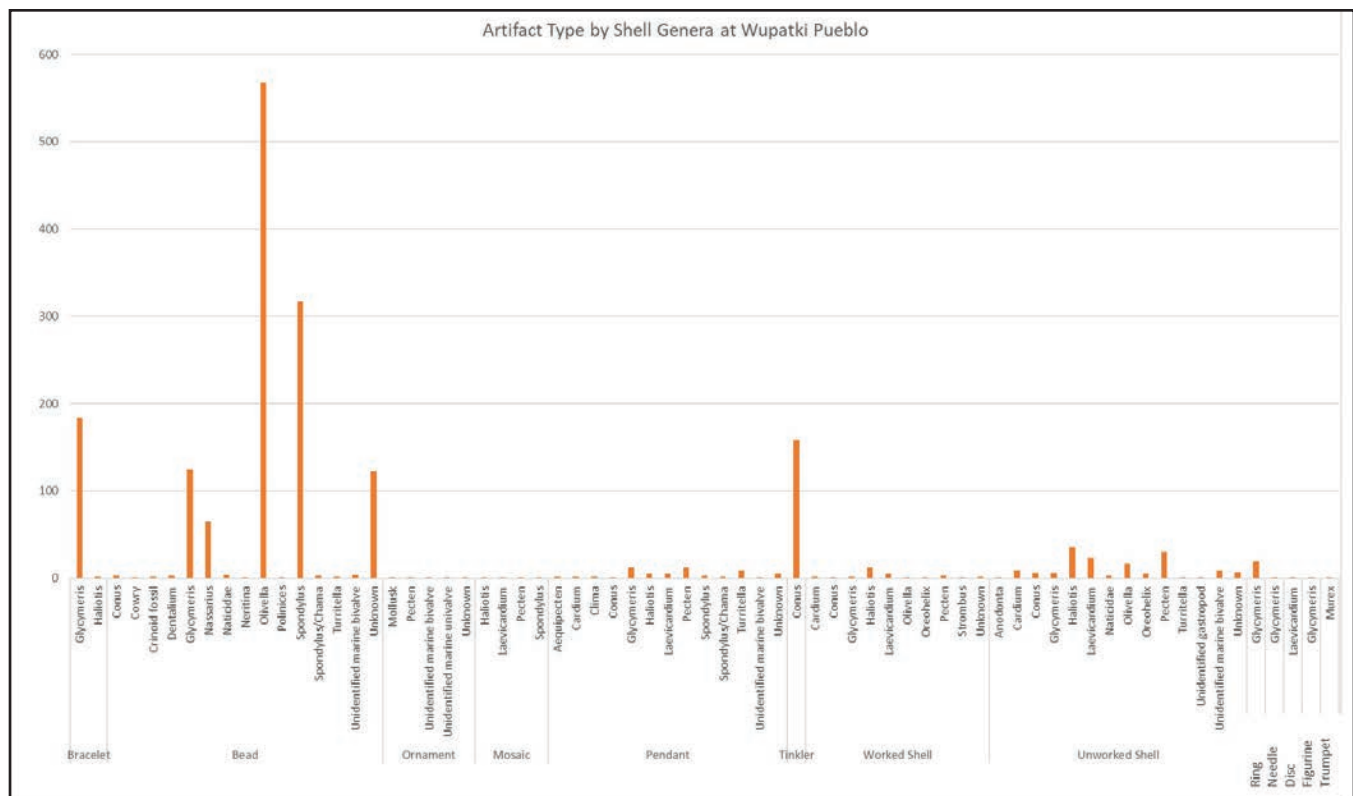


Figure 8. Frequency of artifact types and shell genera at Wupatki Pueblo.



60 percent of the shell assemblage from Wupatki Pueblo exhibits Hohokam style.

Most artifacts that are Hohokam in style are *Olivella* and *Spondylus* beads (Figure 9). These consist of disc, tubular, bilobed, and tabular beads, which are Hohokam in style.

The next most prevalent Hohokam style artifact are *Glycymeris* bracelets (Figure 10). Out of 184 *Glycymeris* bracelets, 182 are Hohokam in style. *Glycymeris* bracelets are a signifier of being Hohokam and the high presence of Hohokam style *Glycymeris* bracelets at Wupatki Pueblo indicates a strong Hohokam presence due to migration or trade or a combination of the two.

In addition to Hohokam style beads and bracelets are tinklers and figurines. The majority of *Conus* tinklers at Wupatki Pueblo are unmodified, but four exhibit incising. Figurines depict the forms of humans, lizards, and frogs.

Finally, pendants found at Wupatki Pueblo differ in shape and exhibit Hohokam style. The pendants at Wupatki Pueblo exhibit oblong, tabular, disc, hook, needle, bilobed, bird, flying bird, lizard, rattlesnake, sunburst, and phallic shapes. Because pendants are very distinct to time periods, the pendants indicate that the shell from Wupatki Pueblo is contemporaneous to the Ho-

hokam Colonial, Sedentary, and Classic periods. Wupatki Pueblo is almost entirely contemporaneous with the Classic period although there are deposits dating to the Colonial and Sedentary periods. This indicates that the Hohokam style shell at Wupatki Pueblo ranged from AD 750 to AD 1450, which is contemporaneous with the Ancestral Puebloan chronology of Pueblo I to Pueblo IV, which ranges from AD 750 to AD 1400. Since Wupatki Pueblo was occupied from AD 900 to AD 1275, the Hohokam style shell artifacts fit into the appropriate range of late Colonial, Sedentary, and early to middle Classic periods in Hohokam chronology. Since the date ranges correlate, they provide an even stronger example of Hohokam influence through trade, migration, or both occurring at Wupatki Pueblo.

### WUPATKI PUEBLO COMPARED TO SINAGUA SITES

The Sinagua sites have a total of 2,071 shell artifacts. The shell assemblage consists of 26 different genera and 17 different artifact types. The completeness of shell at the Sinagua sites ranges from fragmented to whole. The Sinagua sites have evidence of burnt, polished, incised, and reworked shell.



Figure 9. Two *Olivella* whole beads, one *Olivella* tubular bead, eight *Spondylus* disc beads, four *Spondylus* bilobed beads, one *Spondylus* tabular bead, and nine *Glycymeris* whole beads (Image by author 2017).



Figure 10. *Glycymeris* bracelet from Wupatki Pueblo (Image courtesy of Ryan Belnap, Dan Boone, and Christian E. Downum 2011).

Wupatki Pueblo and the Sinagua sites share 14 of the same shell genera. Both the Ancestral Puebloan and Sinagua sites had *Olivella* as the most prevalent shell genera present and *Glycymeris* as the second most prevalent.

Wupatki Pueblo and the Sinagua sites have seven artifact types in common: bead, bracelet, pendant (Figure 11), tinkler, ring, worked shell, and unworked shell. At both Wupatki Pueblo and the Sinagua sites beads are the most prevalent and bracelets are the second most prevalent.

There is a presence of fragmented and whole shell artifacts at Wupatki Pueblo and the Sinagua sites. The condition of shell artifacts plays a part in illuminating the presence and influence of the Hohokam on the Sinagua. Both Wupatki Pueblo and the Sinagua sites have beads as the most commonly found whole objects. The most commonly found fragmented objects in both cultures are bracelets. Wupatki Pueblo has a high presence of fragmented tinklers, while the Sinagua sites have a high presence of fragmented beads, pendants, and unknown artifacts.

Both Wupatki Pueblo and the Sinagua sites have burnt, polished, incised, and reworked shell. What is unusual about the Sinagua sites is that two sites, Elden Pueblo and Winona Village, have evidence of shell

debitage. Debitage was recovered at Winona Village (O'Hara 2012), but not at the Winona Village complex sites analyzed in this study. There is no evidence of shelldebitage at Wupatki Pueblo or Ridge Ruin indicating shell manufacturing most likely occurred at Elden Pueblo and Winona Village, but did not take place at Wupatki Pueblo or Ridge Ruin.

### WUPATKI PUEBLO COMPARED TO HOHOKAM SITES

The Hohokam sites have a total of 11,353 shell artifacts. The shell assemblage consists of 24 different genera and 12 different artifact types. The completeness of the shell ranges from fragmented to whole. There is evidence of burnt, incised, painted, and polished shell. There is also evidence of shelldebitage.

Wupatki Pueblo and the Hohokam sites have 11 genera in common. Both Wupatki Pueblo and the Hohokam sites have *Olivella* as the most prevalent genus and *Glycymeris* as the second most prevalent genus. *Spondylus* is the third most prevalent genus at Wupatki Pueblo yet it is rarely found at the Hohokam sites. *Laevicardium* is the third most prevalent genus at the Hohokam sites yet *Laevicardium* is not prevalent at Wupatki Pueblo.



Figure 11. *Laevicardium* frog pendant from Elden Pueblo (Image courtesy of Peter J. Pilles, Jr. and Walter Gosart 2015).

Wupatki Pueblo and the Hohokam sites have eight artifact types in common: bead, bracelet, figurine, needle, pendant, ring, tinkler, and unworked shell. At both Wupatki Pueblo and the Hohokam sites beads are the most prevalent artifact type and bracelets are the second most prevalent. At Wupatki Pueblo tinklers are the third most prevalent artifact type yet at the Hohokam sites unworked shell is the next most prevalent artifact type.

There are similarities and differences between Wupatki Pueblo and the Hohokam sites in terms of what types of artifacts are fragmented and what types are whole. The most commonly found whole objects at Wupatki Pueblo and the Hohokam sites are beads. The most commonly found fragmented objects at Wupatki Pueblo are bracelets and tinklers and the most commonly found fragmented objects at the Hohokam sites are bracelets.

Both Wupatki Pueblo and the Hohokam sites have burnt, incised, and polished shell. Both have burnt bracelets, incised rings, and polished bracelets. Shell debitage is present at the Hohokam sites, but is not present at Wupatki Pueblo indicating shell manufacturing was occurring at the Hohokam sites, but not at Wupatki Pueblo.

## CONCLUSIONS

In conclusion, there is a strong connection between Wupatki Pueblo and the Hohokam. The people of Wupatki Pueblo were not manufacturing shell objects. Instead, the Hohokam were manufacturing shell objects and trading these objects north to Wupatki Pueblo. The absence of shell debitage or shell manufacturing stone tools at Wupatki Pueblo indicates shell manufacturing was not occurring there but instead, shell artifacts were being traded in by the Hohokam. Minimal shell manufacturing is evident at two Sinagua sites, Elden Pueblo and Winona Village, but most of the shell at the Sinagua sites was manufactured by the Hohokam which can be seen by the large quantity of Hohokam style shell artifacts at these Sinagua sites. The quantity of shell, genera of shell, and shell artifact types at Wupatki Pueblo are like that of the Sinagua sites. This indicates there is a similar influential relationship between the Hohokam and Sinagua. The quantity of shell at Wupatki Pueblo and the Sinagua sites is significantly smaller than at the Hohokam sites. This pattern suggests down-the-line trade rather than Hohokam traders living at Wupatki Pueblo and the Sinagua sites. The people of Wupatki Pueblo likely exchanged turquoise, ceramics, or lithics with the Hohokam for shell artifacts. The Hohokam are mainly represented by artifacts such as shell ornaments and red-on-buff ceramics at Wupatki Pueblo and the Sinagua sites. For architecture, ballcourts are present at Winona Village, Ridge Ruin, and Wupatki Pueblo indicating that there was some sort of Hohokam influence on these sites. Therefore, based on the data presented in this article, there is a strong connection between Wupatki Pueblo and the Hohokam.

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# CRUSHING THE TRADITIONAL HOHOKAM TYPOLOGY: GROG (CRUSHED SHERD) TEMPER FROM PUEBLO PATRICIO

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*Analysis of recently excavated ceramics from AMS-dated Early Formative contexts at AZ T:12:70 (ASM)/Pueblo Patricio in Phoenix, Arizona identified grog (i.e., crushed pottery) and local tempering materials, as confirmed by petrographic analysis. Single grain optically stimulated luminescence provides additional evidence of early grog-tempered ceramic production dates. Previous ceramic analyses within the Lower Salt River Valley viewed grog temper as common in Classic, Protohistoric, and Historic time periods but very rare to nonexistent in Preclassic contexts. This study expands the use of grog temper to AD 250–750. This evidence of prehistoric variability in ceramic production within the Lower Salt River Valley offers another avenue for exploring the Hohokam's origins and development.*

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This paper summarizes the results of multiple studies that stemmed from a chronological assessment of archaeological features at the site of AZ T:12:70 (ASM)/Pueblo Patricio within Block 23 of Phoenix, Arizona (Figure 1). The results of the initial temporal analysis presented below yielded conflicting results, specifically among Hohokam grog-tempered plain ware pottery and the dates of the features from which they came. Because the initial sample was small, and the potential the results were erroneous, we needed to replicate our findings and incorporate other testing methods. The results call into question our understandings of Preclassic Hohokam pottery manufacture in the Salt-Gila Basin. This paper is organized into discrete sections to help convey our path of investigation and discovery.

In 2017 we conducted an analysis of ceramic artifacts collected during Logan Simpson's excavations at AZ T:12:70 (ASM)/Pueblo Patricio within Block 23 of Phoenix, Arizona. Pueblo Patricio was an intermittently occupied habitation situated on the north bank of the Salt River (Henderson 1995). Chronological analyses suggest a roughly 1,200-year span of occupation from the Red

Mountain phase through the Classic period (ca. AD 250–1450), albeit with one or more possible occupation hiatuses during that span. The ceramic material included in this study was recovered from contexts related to several contemporaneous pits and fragmentary residential features within the site.

A total of 356 individual ceramic artifacts were recovered. This total when calculated for minimum number of vessels (MNV) is reduced to  $n = 323$  sherds. MNV reduces the collection size by calculating as a count of one, any sherds inferred to be from the same vessel, regardless of whether those sherds are directly conjoinable. This approach reduces the potential for artificially inflating sherd and attribute frequencies by counting sherds from a single vessel as multiple occurrences. The MNV value is utilized for all the calculations in this study. Most of the sherds were plain ware ( $n = 314$ , 97.2%) and three characteristics of these undecorated ceramics stood out. First, nearly 50% of the sherds included South Mountain granodiorite temper, indicating they were manufactured on the south side of the Salt River. Second, many examples included paste, temper, and surface colors that were strongly reminiscent of Brown Paste Variants (BPVs)—which are locally produced ceramic containers that are decorated in the Middle Gila buff ware idiom (Abbott and Gregory 1988). However, our material did not include any painted decorations. Third, a notable proportion (19.7%) of the plain ware included crushed sherd temper (grog), along with other local tempering materials.

The presence of grog tempered plain ware within three out of four of the residential features investigated led to the initial conclusion that these features represented a Classic or Protohistoric component. This conclusion was reinforced by the recovery of plain ware with grog temper from the investigation of Feature 1, an historic brick foundation (Figure 2). These preliminary conclusions were based on the tra-

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ditional and widely accepted view that grog-tempered pottery was manufactured within the lower Salt River Valley during the Classic period and later, but very rare to non-existent in earlier time periods (Abbott 1994, 1995, 2000, 2001, 2011; Henderson 1995; Wells 2006). However, architectural analyses of the pit house features suggested they had early construction dates. This evidence included small floor size, generally insubstantial construction (few subfloor pits, shallow pit depth, and unprepared floor surfaces) (Cable et al. 1985; Hackbarth 2010, 2012; Henderson 1995). Their depth below modern ground surface also suggested an early date. Two  $^{14}\text{C}$  AMS dates from two pit house features (Features 9 and 17) confirmed these features date to the early part of the Hohokam sequence (Feature 9, Beta #487326 and [95.4%] 420 - 564 cal AD [1530 - 1386 cal BP]; Feature 17, Beta #487327 and [95.4%] 420 - 564 cal AD [1530 - 1386 cal BP]). The early dates of the pit house features where ceramics with grog temper were found raised the question of whether these purported Classic period and/or historic ceramics had infiltrated these features through bioturbation or some other similar mechanism.

A preliminary study was conducted to clarify the production date of the grog-tempered plain ware question. For this study, we submitted one sherd for single-grain optically stimulated luminescence (SG-OSL) analysis to resolve the age of artifacts and hence associated features. This method has the advantage of directly dating the manufacture of a ceramic vessel, unlike the indirect nature of radiocarbon dating events wherein unaccounted bridging events (see Dean 1978) can result in erroneous temporal designations. This challenge is mostly encountered in Hohokam contexts as the “old wood problem” (after Schiffer 1987). Positive results within the preliminary study led to the submission of four additional SG-OSL samples, and precipitated the need to confirm, through petrography, that the inclusions we characterized as grog within the initial analysis, were in fact grog.

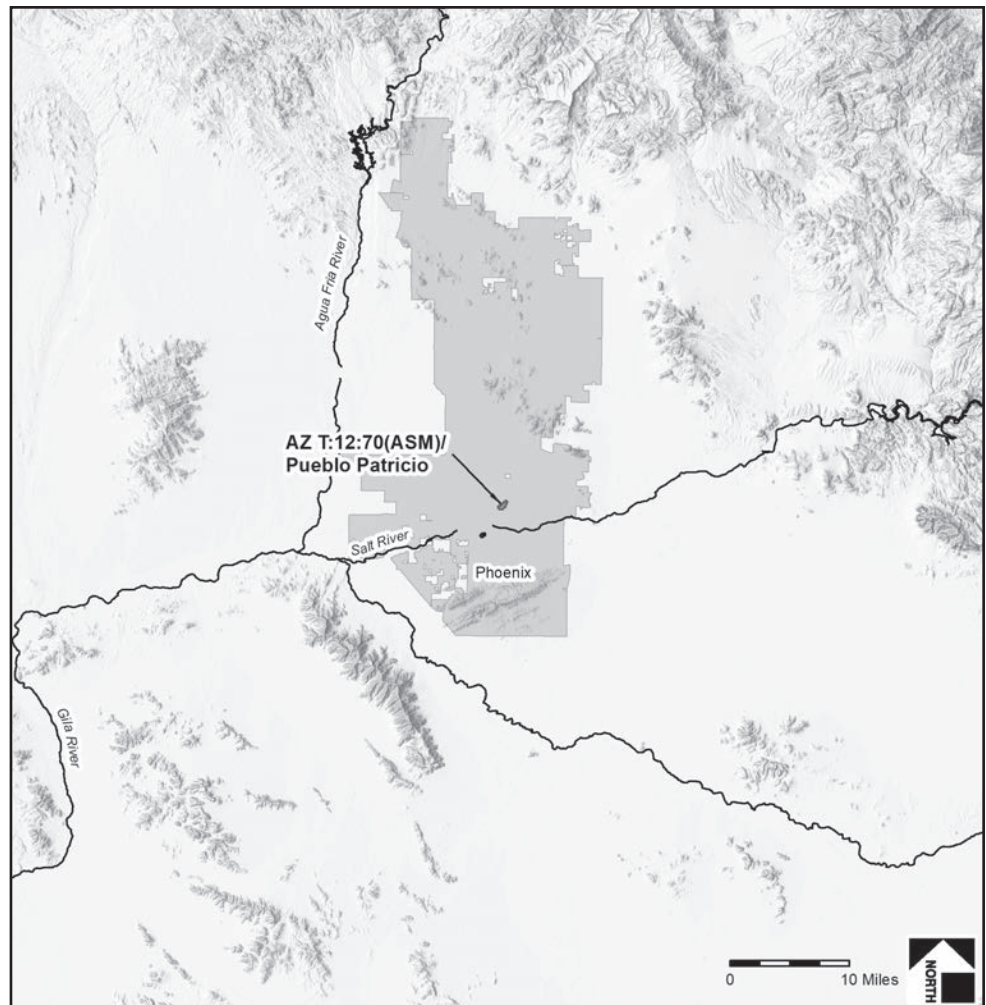


Figure 1. Location of Phoenix and AZ T:12:70(ASM) and the lower Salt River drainage.

## LUMINESCENCE METHODS

For our study, selecting sherds as candidates for SG-OSL dating involved balancing four criteria. The first prerequisite was that the candidate sherd's paste had to include morphological and compositional attributes that could be construed as grog. Second, the sherd should include abundant quartz within its paste because it is the key mineral target for SG-OSL dating – the more common these grains are within the sherd, the more likely a sound date will be obtained. Third, the sherds had to be sufficiently thick so that abrading the surfaces of the sherd would encounter feldspar or quartz grains that had not been exposed to light after the original firing episode. Finally, the candidate sherd could not have evidence of a re-firing event. Intense heat after deposition could reset the internal clock within the key grains targeted during the SG-OSL analysis. This latter point may not be a major issue when a secondary thermal event occurred within a few years subsequent to the sherd's

initial firing and deposition; however, in a long-lived village such as Pueblo Patricio, the potential for an anomalous date reflective of a secondary thermal event after initial firing increases. Therefore, the selection process excluded candidate sherds that were recovered from burned contexts.

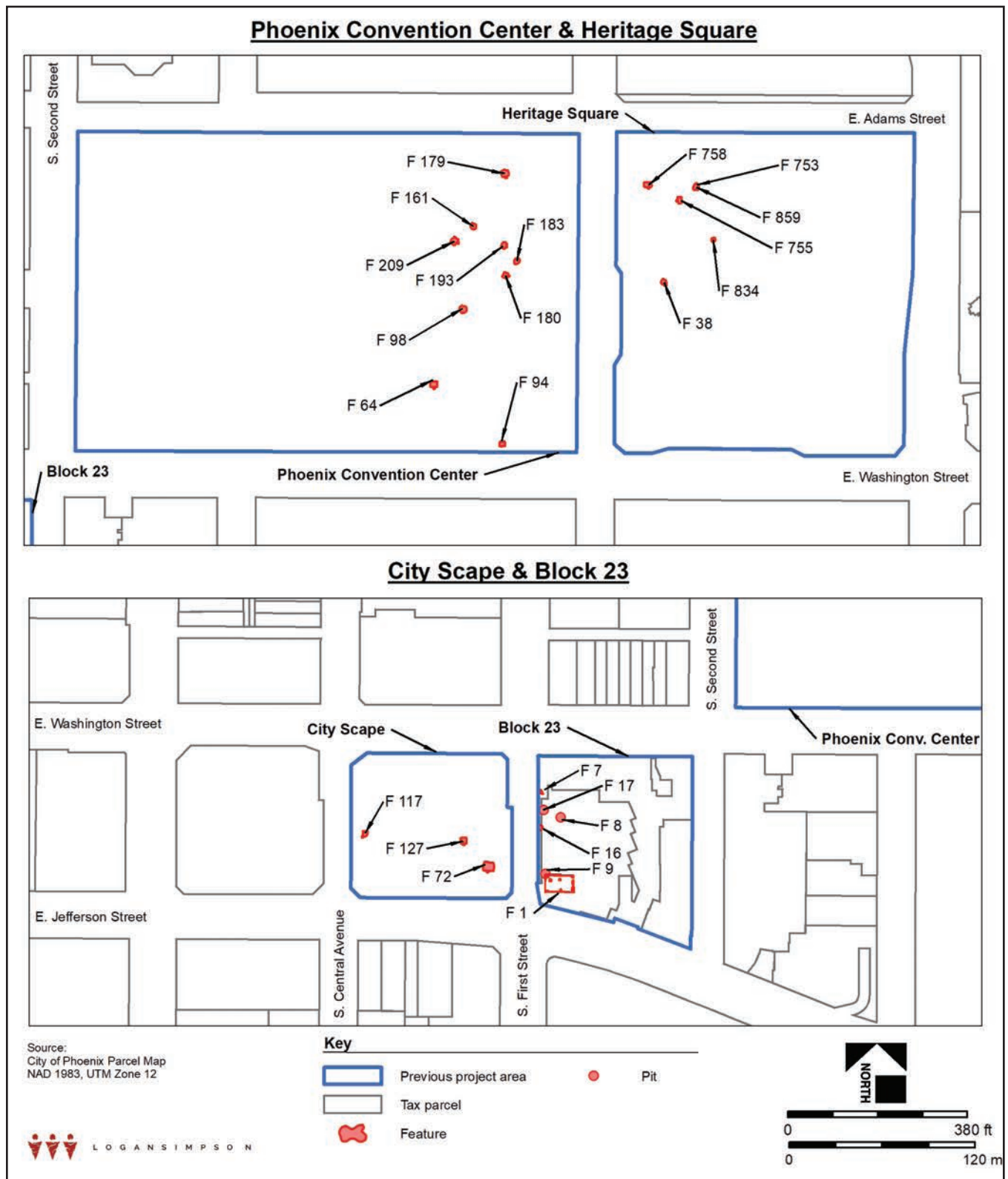


Figure 2. Location of features at AZ T:12:70 (ASM)/Pueblo Patricio as identified by the Block 23, Heritage Square, Phoenix Convention Center, and CityScope projects, Phoenix, Arizona.

Luminescence dating is a method where charged particles generated through environmental radiation are utilized to date when specific grains within a sherd were last exposed to light or subjected to high heat, such as is the case when a ceramic container is fired. These particles accumulate over time within the flaws in the crystalline structure of those grains, specifically quartz and feldspar. When these grains are subjected to sufficient energy, the stored particles are released in the form of light (Feathers 2003: 1493). Quartz and feldspar include properties that result in stable and well-known accumulation of these particles over time. The date is calculated by measuring the amount of light that is released, provided the rate of particle accumulation is properly measured. The light energy released results in a zeroing event where the individual tested grains are emptied of their charged particles in a simulation of the same mechanism as would occur when the ceramic was exposed to high heat, or the individual grains were exposed to the sun. Once this release of energy is measured, further measurements are made through exposing the material to calibrated amounts of radiation to determine the rate at which luminescence signals are generated in the sample (Lipo et al. 2007). To get a controlled result, it is necessary to have a good estimate of the background radiation present within the sediment surrounding the ceramic sample that was the source of the charged particles stored within the target grains. As such, a soil sample is submitted for analysis along with the ceramic material. This soil sample is utilized to determine the annual dose rate of radiation present within the environment by measuring radioactive elements such as thorium, uranium, and potassium within the soil sample. Through these techniques, the amount of previously accumulated charged particles, along with the sensitivity of the sample to radiation, and the amount of radiation the sample was subjected to annually, a date can be derived from the last time that material was subjected to high heat or the interior particles were subjected to sunlight. This date is representative of when the key target grains were last emptied of their charged particles, i.e., the last zeroing event (Lipo et al. 2007). In the case of the material from the Block 23 Project, our hope was that the resulting date would be reflective of when the sherds were fired at their time of manufacture, or in the case of sherds derived from cookware, possibly when the vessel was last utilized to cook food.

Four ceramic sherds were submitted to Utah State University (USU) for analysis and processed under dim amber safelight conditions. The outer ~2 mm of each sherd was removed with a small handheld drill at the lowest setting. This light-exposed material was submitted for chemical analysis to calculate the dose rate contribution from the sherd. The inner ceramic material was lightly disaggregated and processed for quartz optically stimulated luminescence (OSL) dating following standard procedures-- sieving, gravity separation and

acid treatments with HCl and HF to isolate the quartz component of a specific grain-size range, 63-250  $\mu\text{m}$ . The purity of the quartz samples was checked by measurement with infra-red stimulated luminescence (IRSL) to detect the presence of feldspar.

The USU Luminescence Laboratory follows the latest single-aliquot regenerative-dose (SAR) procedures for SG-OSL dating of quartz sand (Murray and Wintle 2000, 2003; Wintle and Murray 2006; Duller 2008). The SAR protocol includes tests for sensitivity correction and brackets the equivalent dose (DE) the sample received during burial by irradiating the sample at different doses (above the DE, plus a zero dose and a repeated dose to check for recuperation of the signal and sensitivity correction). The resultant dose-response data are fit with a linear regression, from which the DE is calculated on the Central Age Model (CAM) of Galbraith and Roberts (2012) of the accepted grains. Grains are rejected based on results of repeat point (>30% of unity) and zero-dose steps (>1Gy recuperation) during SAR analysis. The SG-OSL ages are reported at  $2\sigma$  standard error and calculated by dividing the DE (in grays, Gy) by the environmental dose rate (Gy/ka) that the sample has been exposed to during burial.

Dose-rate calculation was determined by radio-elemental analysis of the U, Th, K and Rb content using ICP-MS and ICP-AES techniques and conversion factors from Guérin et al. (2011). Total quartz OSL dose rate was calculated using beta and gamma dose contribution from the sherd and gamma from soil dose rate sample-scaled to sherd thickness. The contribution of cosmic radiation to the dose rate was calculated using sample depth, elevation, and latitude/longitude following Prescott and Hutton (1994). Dose rates are calculated based on water content, sherd and soil chemistry, and cosmic contribution (Aitken 1985).

## FIRST ROUND OF SG-OSL RESULTS

The first SG-OSL dating sample submitted to the USU Luminescence Laboratory was a sherd with grog temper from a pit house (Feature 7, Sample FN 107.01). The sample returned an SG-OSL date of AD 390–630 (Rittenour 2019) indicating that the vessel the sherd originated from was fabricated sometime during the late Red Mountain (AD 1–450) or early Vahki (AD 450–600) phases. The SG-OSL evidence agreed well with the two  $^{14}\text{C}$  AMS dates (both AD. 420–564) from two other pit houses included in the study (Features 9 and 17) (Figure 2).

## Secondary Study

To further reinforce our results, we expanded our sampling strategy to include other projects that had investigated Pueblo Patricio and recovered ceramic artifacts that might include grog temper. The parameters of the expanded SG-OSL dating study were determined



by searching the published literature for archaeological excavations in Pueblo Patricio with radiocarbon dated Red Mountain and Pioneer occupations, including Heritage Square (Henderson 1995), CityScape (Hackbarth 2012), and the Phoenix Convention Center (Hackbarth 2010) (Figure 2). Ceramic analyses of previously dated pit house features from these portions of the site were examined for descriptions of grog temper within each feature's collections.

The literature search demonstrated that grog temper was found in dated contexts of only Heritage Square (Henderson 1995) and was not mentioned within the results of the Phoenix Convention Center project nor the CityScape project. Further, a petrographic analysis was performed on a selection of 13 sherds and two clay samples during the Phoenix Convention Center project as well as a sherd from Red Mountain phase deposits from sites: AZ U:6:213 (ASM)/La Escuela Cuba, AZ U:10:2 (ASU)/ Red Mountain, and AZ V:13:201 (ASM)/Kearny (Hill 2010). That study did not document grog temper in its analyzed sample. Finally, the ceramics chapter for the CityScape project likewise did not include any mention of grog. Even so, we supposed that these analyses identified the primary tempering agents within the early material but had missed the grog. The literature search produced a total of 18 features with early dates derived through their morphology as well as analytic methods which included radiocarbon and archaeomagnetic dating, (Table 1). Once the feature list was compiled, we requested access to the ceramic collections curated at Pueblo Grande Museum (PGM).

Ceramics from the dated features were examined using a binocular microscope. Sherds selected for the analysis were minimally 1.5 cm<sup>2</sup> or larger. This preference for large sherds was necessitated by the need to send half of the sherd for the second round of SG-OSL testing and have the remaining half available for thin sectioning and petrographic analysis. The methods used to identify grog particles during the initial ceramic analysis were adapted from Abbott's (1994) analysis of ceramic artifacts at Pueblo Grande, AZ U:9:1 (ASM). Abbott (1994:267) noted:

Grog fragments are recognizable in pottery pieces by their distinct color in comparison with the surrounding matrix, and sometimes by rock-fragment inclusions (i.e., temper in temper). Sherd temper was coded as visible when at least three grog fragments were identified, and at least one of these fragments contained obvious rock inclusions. The last requirement ensured that clay chunks resulting from the incomplete preparation of the clay body were not misidentified as intentionally added grog.

### PGM Study Results

The number of sherds identified is undoubtedly less than the actual number present within these features, due, in part, to our sampling strategy that targeted larg-

er sherds and also to challenges confronted during the analysis. Many of the sherds were either dirty or lacked fresh, clean breaks in which to view the paste and temper, some sherds that may have included grog did not meet the three necessary grog-like inclusions needed to make a positive grog identification, and so were not included in the results. Based on these criteria we identified 90 plain ware sherds that exhibited inclusions consistent with grog within their paste (Table 2). These sherds represented collections from 11 features and 1 sub feature.

Grog inclusions in many of the PGM artifacts are pink in color. This characteristic was observed in the material from Block 23 and was also noted by Henderson (1995) in her initial analysis of the Heritage Square assemblage. Further, many of the Heritage Square bags had Henderson's original typological number from the initial analysis written on them, and several of the sherds included those designations written in pencil on their surfaces. All the Henderson 1995 type codes encountered during the re-analysis that corresponded to the presence of grog also included South Mountain granodiorite temper.

Two features examined during the reanalysis require further mention. Feature 758 from Heritage Square included a bag (Specimen 678) which had within it smudged and polished plain ware sherds and a few Salado polychrome sherds. This is direct evidence that some level of mixing had taken place within that feature because an archaeomagnetic date from that feature places its use in the Red Mountain phase. As such, materials from Specimen 678 were not considered further in this study. A single bag from Feature 755 at Heritage Square (Specimen 1009) included a set of three re-conjoinable bowl rim sherds with a worked edge. The sherds included a weak but definite polished slip on both the interior and exterior surfaces. The primary tempering material within the sherds is South Mountain granodiorite in association with very prominent pink grog inclusions. These sherds were the only red wares identified during the analysis of grog-tempered sherds housed at PGM. Based on its decoration, including the weak slip and polish present on both surfaces, combined with its potential date within the early time period, and its lack of mica, this sherd is arguably consistent with a locally manufactured version of the heavily micaceous Vahki Red.

The sample of four sherds that our team selected for both SG-OSL and petrographic analysis included Sample FN 689 recovered during the Heritage Square Project from pit house Feature 758, Sample FN 1532 recovered during the Block 22 Project from pit house Feature 127, and two samples from the Phoenix Convention Center Project, Sample FN 1011 recovered from pit house Feature 64 and Sample FN 2098 from pit house Feature 98. All of the selected sherds met the compositional criteria discussed above. However, one

**Table 1. Features from Pueblo Patricio targeted for grog identification at PGM.**

Feature	Project	Date 1 <sup>c</sup>	Date 2 <sup>d</sup>	Phase classification
38	HS <sup>a</sup>	AD 40–380	30 BC–AD 240	Early Red Mountain (AD 1–250)
753	HS <sup>a</sup>	AD160–550	stratified feature <sup>e</sup>	Red Mountain (AD 1–450)
755	HS <sup>a</sup>	AD 230–550	Amag preferred option is AD 350–575 using SWCV2010 <sup>f</sup>	Red Mountain (AD 1–450)
758	HS <sup>a</sup>	AD 120–530	Amag preferred option from pit house is AD 350–600 using SWCV2010 <sup>f</sup>	Red Mountain (AD 1–450)
834	HS <sup>a</sup>	AD 230–550	–	Late Red Mountain (AD 250–450)
859	HS <sup>a</sup>	AD 340–600	stratified feature <sup>g</sup>	Late Red Mountain (AD 250–450)
64	PCC <sup>b</sup>	AD 420–610	Amag preferred option is AD 550–765 using SWCV2010 <sup>f</sup>	Late Red Mountain (AD 250–450)
94	PCC <sup>b</sup>	AD 350–570	–	Late Red Mountain (AD 250–450)
98	PCC <sup>b</sup>	AD 380–550	Second <sup>14</sup> C sample from Feature 98 has four options (AD 260–280, 330–450, 450–460, and 480–530) <sup>h</sup>	Late Red Mountain (AD 250–450)
161	PCC <sup>b</sup>	AD 440–490, 520–640	–	Late Red Mountain (AD 250–450)
179	PCC <sup>b</sup>	AD 250–420	Amag preferred options are AD 200–475 and AD 400–690 using SWCV2010 <sup>f</sup>	Late Red Mountain (AD 250–450)
180	PCC <sup>b</sup>	AD 140–380	–	Early Red Mountain (AD 1–250)
183	PCC <sup>b</sup>	AD 240–420	Amag preferred option is AD 1–400 using SWCV2010 <sup>f</sup>	Late Red Mountain (AD 250–450)
193	PCC <sup>b</sup>	AD 240–420	–	Late Red Mountain (AD 250–450)
209	PCC <sup>b</sup>	AD 130–350	Amag preferred option is AD 350–675 using SWCV2010 <sup>f</sup>	Early Red Mountain (AD 1–250)
72	CityScape	AD 420–610	AD 540–650	Late Red Mountain (AD 250–450)
117	CityScape	Cienega long projectile point <sup>j</sup>	Amag preferred option is AD 550–765 using SWCV2010 <sup>f,i</sup>	Early Red Mountain (AD 1–250)
127	CityScape	AD 140–560	Amag preferred option is 500 BC – AD 113 using SWCV2010 <sup>f</sup>	Early to late Red Mountain (AD 1–450) and Vahki (AD 450–700)

<sup>a</sup> = Heritage Square; <sup>b</sup> = Phoenix Convention Center; <sup>c</sup> = AMS date associated with feature, 2-sigma calibrated dates unless indicated otherwise; <sup>d</sup> = second AMS or alternative dating method for context; <sup>e</sup> = Feature 753 is above Feature 859, which truncates possible date range of Feature 753 to AD 160–340; <sup>f</sup> = Re-dated features from Pueblo Patricio using SWCV2010 to be published (Hackbarth 2019); <sup>g</sup> = Feature 859 is below Feature 753, which truncates possible data range of Feature 859 to AD 340–550; <sup>h</sup> = Feature 98 has one 2-sigma date range of: AD 260–280, 330–450, 450–460, and 480–530; <sup>i</sup> = reanalysis of sample using SWCV2010 has four date options, but only two options (500 BC to AD 150 and AD 1–400) cross dates with projectile point; <sup>j</sup> = Cienega long projectile point date to 70 BC–AD 200.

sherd, FN 2098 was too small to include half for the petrographic portion of the study. It was replaced by a sample (FN 107.02) from pit house Feature 7 (Block 23 Project). The selection of alternate Sample FN 107.02 was based on the presence of inclusions consistent with grog temper within the sherd, the fact that it was not going to be dated using SG-OSL, and the fact that it exhibited accessory temper grains distinct from all the other samples. FN 107.02 included unknown sand temper, which was inconsistent with South Mountain granodiorite; its petrographic analysis could, therefore, provide information on variability of production locale of these grog tempered sherds.

As stated in the methods section, to achieve controlled results, it was necessary to include a soil sample with each of the sherds submitted for SG-OSL analysis

for use in estimating the amount of background radiation each sample sherd was subjected to while it was buried. These soil samples needed to be taken from near the recovery location of each sherd. Fortunately, in every case, PGM had curated an applicable soil sample from each of the selected features.

## Second Round of SG-OSL Results

The initial round of SG-OSL testing conducted on a sherd recovered from pit house Feature 7 (FN 107.01) recovered during the Block 23 project returned an SG-OSL date of AD 390–630 (Rittenour 2019). The chronometric results for this sherd were subsequently re-evaluated using baseline data gathered from the soil control samples analyzed during the second round of SG-OSL testing. The subsequent refined date for Sam-

**Table 2. Results of the reanalysis of sherds from Red Mountain phase residential features at Pueblo Patricio.**

Project	Feature	Specimen numbers with grog	Count	Context <sup>a</sup>	Notes
PCC <sup>b</sup>	64	871, 891, 927, 930, 940, 1011, 1017, 1022	13	10 and 19	Pink grog very apparent in sherds
CityScape	72	572, 701, 601, 994, 1001	9	20	Caliche present in one sherd
PCC <sup>b</sup>	94	1425, 1551	2	19, 20	
PCC <sup>b</sup>	98	1574, 1800, 1919, 1995, 2098	9	10, 19, 20	Sherd from FN 2098 sent, pink grog represented, sherds present with phyllite or schist and grog.
CityScape	127	1439, 1443, 1479, 1484, 1532, 1537, 1584,	11	10, 19, 20	Sherds present with large amounts of grog
CityScape	127.01	1582	1		Exhibits an oxidized surface
PCC <sup>b</sup>	183	2802, 2550, 2533, 2545	5	19	Pink grog present along with other colors, some exhibit finer grog inclusions
PCC <sup>b</sup>	193	2945, 2892,	3	19	Pink grog present
HS <sup>c</sup>	753	135, 3048	3	No data	2 labeled "Type 10" <sup>d</sup>
HS <sup>c</sup>	755	479, 551, 554, 651, 774, 804, 1008, 1009	12	No data	3 labeled "Type 10" <sup>d</sup> , 2 marked "Type 61" <sup>e</sup> including one re-conjoinable set of sherds that consist of redware slipped on both surfaces.
HS <sup>c</sup>	758	678, 689, 702, 716, 878	23	No data	10 marked "Type 61" <sup>e</sup> , 3 marked "Type 10" <sup>d</sup> , and one marked "Type 12" <sup>f</sup> , bag 678 includes smudged plain ware, and some Salado Polychrome.
HS <sup>c</sup>	859	3236	1	No data	

<sup>a</sup> = (Context 10 = undifferentiated house fill); (Context 19 = 10 cm above house floor surface); (Context 20 = in contact with house floor). <sup>b</sup> = Phoenix Convention Center; <sup>c</sup> = Heritage Square; <sup>d</sup> = Henderson 1995 Type 10 = South Mountain granodiorite; <sup>e</sup> Henderson 1995 Type 61 = opaque white grains (likely South Mountain granodiorite) and grog; <sup>f</sup> Henderson 1995 Type 12 = white grains (like Type 10) but with abundant gold mica (muscovite) and black mica (biotite).

ple FN 107.01 is AD 540–800. One sherd, FN 2098, was deemed to be inappropriate for SG-OSL upon receipt at the USU Luminescence Laboratory. The sample was too thin and exhibited an eroded surface which the analysts felt would cause the sample to produce an unreliable date. As such, Sample FN 2098 was dropped from the luminescence portion of the study. The second round of SG-OSL testing produced dates within the Red Mountain and Vahki phases, although two extend into the Colonial period. Sample 689 (Feature 758/Heritage Square [AD 600–840]), Sample 1011 (Feature 64/Phoenix Convention Center [AD 130–490]), and Sample 1532 (Feature 127/Block 22/CityScape [AD 630–870]).

### Petrographic results

The petrographic analysis was carried out at Desert Archaeology, using standard qualitative methods. Three sherds had analogous sand temper, Sample 689, Sample 1011, and Sample 1532 all contained granite fragments with strong gneissic/mylonitic textures. The granite has some quartz, but mostly potassium feldspar, altered plagioclase, and rare microcline. Infrequent inclusions are biotite, muscovite, amphibole, chlorite, opaques, and sphene. All contained inclusions of crushed pottery, with Sample 689 also having the same temper as the sherd itself. Sample 1532 with more notable schist and

phyllite rock fragments contained grog with some of these schist and phyllite inclusions suggesting the grog could be the source for these fragments. Other grog pieces did not contain such metamorphic rocks. Sample 107.02 had common mafic volcanic grains, likely basalt, and grog. Inclusions of granite (quartz, potassium feldspar, altered plagioclase) were rare, with gneiss and schist grading to phyllite being even less common.

The sand temper characteristics were compared to sand samples collected throughout the Phoenix Basin used to create a petrofacies map for that area (Miksa et al. 2004). Petrofacies are discrete sand composition zones identified through statistical analysis of point-count data from sand thin sections. They also represent unique raw material acquisition areas. Pueblo Patricio is in the Phoenix Mountains (V) Petrofacies with sand characterized by schist and phyllite, and uncommon granite and volcanic grains (Figure 3). The sand in samples 689, 1011, and 1532 is distinctive of the Estrella gneiss present in the western half of South Mountain (Reynolds et al. 1986). This is within the South Mountain (Q) Petrofacies (see Figure 3). On the other hand, Sample 107.02 was likely produced in the Lookout (Y) Petrofacies located at the northern end of the Phoenix Mountains. This area contains Tertiary basalt with some schist outcrops in the larger area (Johnson et al. 2003). This petrofacies



was not identified in petrographically analyzed pottery from La Villa, Pueblo Grande, and AZ T:12:288 (ASM) near Pueblo Patricio (Ownby 2014, 2016; Ownby and Lavayén 2013, 2015). The current study provides a suggestion for some pottery manufacture in this area that utilized sand and grog temper.

Based on ethnographic data, potters will typically travel 1–3 km for sand temper (Heidke 2011: Table 4). The 3-km area around Pueblo Patricio is within the Phoenix Mountains (V) Petrofacies but also includes a small part of the Camelback Buttes (I) and South Mountain (Q) Petrofacies (see Figure 3). However, as there were known specialized ceramic producers in the South Mountain area from the Red Mountain phase onward, it is possible none of the four analyzed plain ware sherds were from locally made vessels (Van Keuren et al. 1997). Rather, these pots likely were obtained through exchange, mostly with potters from the South Mountain area, with a single vessel from an area at the north end of the Phoenix Mountains. This pattern of plain ware acquisition was not unusual along the Salt River (see Abbott 2009).

## DISCUSSION

First, we will provide some reasons as to why this early utilization of grog in ceramic production within the Phoenix area is only coming to light because of this study, and where grog was being utilized for ceramic production within the greater region. Second, we will discuss our findings from a chronological standpoint within the context of ceramic production within the lower Salt River Valley. Finally, we will discuss the early grog tempered plain ware's potential connection to the BPVs.

### Potential Factors Effecting the Identification of Grog in Early Hohokam Ceramics

Our findings and our methods somewhat mirror a set of investigations conducted by Heidke (2013) involving Agua Caliente phase (AD 50–500) pottery recovered from sites AZ EE:1:153 (ASM), AZ BB:13:398 (ASM), AZ AA:16:745 (ASM), and AZ BB:13:425 (ASM) in the Tucson Basin. Petrographic analysis of material recovered from these sites revealed that the initial analyses had identified a local sand temper but had missed the accessory grog temper found in approximately 20% of the artifacts (Heidke 2006, 2018; Heidke and Ownby 2016). Heidke's (2013) conclusions as to why the grog was missed during the initial analysis provide useful insights. Heidke (2013:105) noted that:

The low frequency of grog documented in Agua Caliente phase pottery is likely the principal reason why ceramicists previously failed to note its presence. Another likely reason is that these small pieces of grog often resemble volcanic sand grains.

The amount of grog identified within the sherds during the current study is quite variable, which argues for using a rigorous method to quantify the amount of grog in sherds for each time period. In some examples it was difficult to visually parse the three inclusions necessary to make a positive identification. However, in other examples, including the artifact with the earliest SG-OSL derived date (Sample FN 1011), grog inclusions were abundant. Within our sample many inclusions exhibited a pink color that stood out readily from the surrounding paste. This made the potential of missing the grog less likely than within the Agua Caliente material, which unlike our own, had grog inclusions that resembled volcanic grains. This may be true only of the material with grog and South Mountain granodiorite temper. Pink grog seems to be associated only with artifacts manufactured within that petrofacies. As a result, the potential to misidentify individual grog inclusions as other non-grog material is not a likely explanation for why this kind of pottery had not been documented previously.

We suggest two factors have contributed to grog temper not being consistently identified in early Phoenix basin contexts. First, in the cases of the CityScape and Phoenix Convention Center projects, the analyst identified the sand temper grains but not the grog. This dovetails with the fact that, simply put, ceramicists look for what has already been documented since we tend to build our conclusions about all things ceramic based on the work of our predecessors. If previous documentation relative to a subject is lacking, then new details may get overlooked simply because ceramicists do not have a template that includes them. The failure to identify the individual grog inclusions should not be construed as reflective of poor work because in most cases the actual grog inclusions are very subtle and difficult to identify and the analyst did not know to look for them.

The second factor was the assumed temporal mixing of deposits, which were used to explain the presence of grog tempered plain ware in collected materials from the Heritage Square project. The analysts involved in the Agua Caliente phase studies (Heidke 2006, 2013, 2018; Heidke and Ownby 2016) had no such assumptions in their area of production, where the utilization of grog is relegated solely to that early time period. In the lower Salt River Valley, production of ceramic containers with grog is known to have increased markedly after AD 1170. This assumption that the presence of grog temper in plain ware conveys a late production date was one of the main arguments used for thinking that the deposits were temporally mixed at Heritage Square. Henderson (1995:90) stated that:

For example, seven plain ware sherds bearing crushed sherd temper were recovered from the early period features. This should not be taken as evidence that crushed sherd temper was being used during the early period, because the sherds are most likely intrusive from later times.

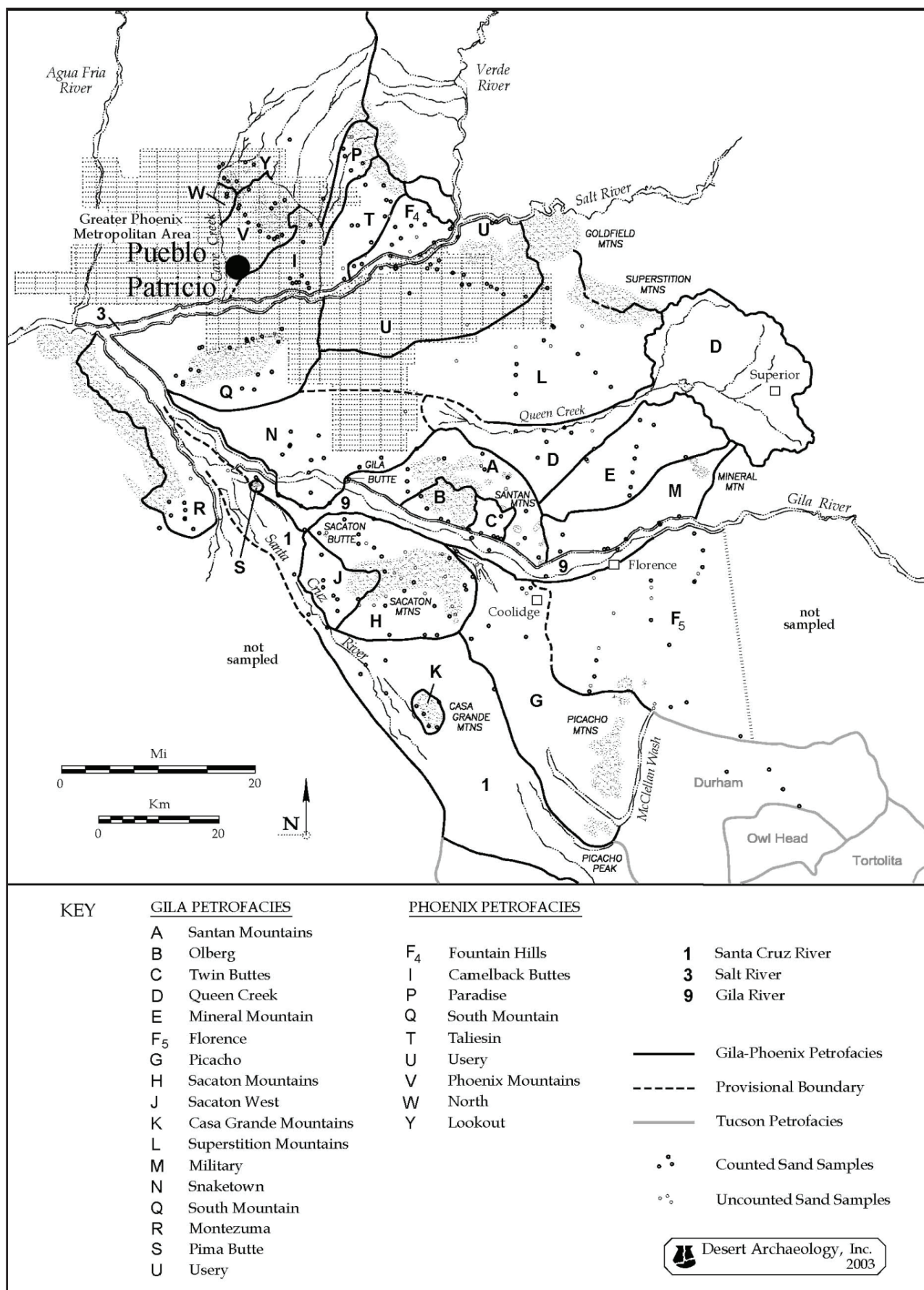


Figure 3. Phoenix Basin petrofacies map.

The portions of the site investigated during the Heritage Square and Block 23 projects at Pueblo Patricio amount to what could be considered the perfect conditions for this misidentification. Both projects found evidence for only very early and very late occupations, with little recovered material dating to the period in between. When confronted by the heavy prevalence of grog within the plain ware at Pueblo Patricio and with a paucity of diagnostic types, it was reasonable to assume that mixing had occurred. The observations described in this study provide persuasive evidence that temporal misidentification is the overwhelming reason why the early use of grog is only coming to light so recently.

### **Implications for the Model of Hohokam Preclassic Ceramic Production**

It is vital to consider Abbott's (2009) regional model of ceramic production within the Phoenix Basin when envisioning how our results fit within the temporal changes and regional supply systems proposed within that model. Utilizing data collected in well-dated, unmixed deposits from 10 settlements, Abbott was able to demonstrate how ceramic production within the Hohokam Core changed during the Preclassic period, from approximately AD 450 to 1170. A brief synopsis of his model is as follows: during the earliest time period when ceramics were produced in the Phoenix Basin, the Red Mountain phase AD 0-450, ceramic containers were made and used locally. Temper profiles were highly variable, reflecting the individual variability of producers during that time. Subsequently, during about the Vahki phase, *circa* AD 450-500, limited craft specialization began, and the production of ceramic containers became the purview of fewer producers. A nascent market economy emerged in which the goods produced began to be disseminated through connections over the greater region. For about 550 years, a small group of potters in specific locations would dominate the market, producing an estimated 90% of the ceramic containers utilized during that period (Abbott 2009).

Of central importance to this discussion is the fact that ceramic producers before and during the proposed 550-year market economy have not been previously demonstrated to utilize grog on a widespread basis. This in turn, necessitates some discussion on where exactly these South Mountain granodiorite-tempered plain wares were produced. Pottery tempered with South Mountain granodiorite is accepted to have been produced near the east end of the South Mountain range, on the south side of the Salt River (Abbott 1994, 2009). This zone of production is considered one of the largest of the major production zones which supplied ceramic containers to consumers within the Phoenix Basin (Abbott 2009). The results of the Heritage Square, Phoenix Convention Center, and CityScape Projects all found that plain ware tempered with South Mountain granodiorite

was the most prevalent pottery type recovered from the early deposits at Pueblo Patricio. The principle of archaeological abundance, which states the most common ceramic variety present at a site was the variety most likely to have been produced locally (Bishop et al. 1980), would reasonably lead to the conclusion that these plain ware vessels were locally produced. However, as the ethnographic evidence documented by Heidke (2011) shows, and as the evidence presented in the petrographic results section of this study indicate, potters did not venture far afield to acquire tempering materials. It is more likely that the material was produced in the South Mountain zone of production as a response to increasing consumer demand at Pueblo Patricio at the dawn of the market economy.

### **Relationship between Grog-tempered Plain Ware and Brown Paste Variants (BPVs)**

During the initial rough sort of material recovered during the Block 23 project, it was noted that sherds with grog and South Mountain granodiorite temper included a very low incidence of biotite flakes present on their surfaces. This observation was consistent with those made in the analysis of the BPVs tempered with South Mountain granodiorite recovered from AZ T:12:1 (ASM)/La Ciudad during the Frank Luke Addition data recovery project and is consistent with other ceramics manufactured with that temper (Garraty 2016). This, along with the general composition and color of some of the plain ware manufactured with grog and South Mountain granodiorite temper, led Bustoz (2017) to suspect some of these sherds may be BPVs scrubbed of their designs by weathering or other post-depositional processes. In-depth studies of the undecorated plain ware manufactured in the South Mountain zone found that potters in that area did not utilize grog in ceramic production until about AD 1170. As such, any noticeable grog utilization within that zone of production during the early period should be considered aberrant.

There is some available evidence that implies these early grog and South Mountain granodiorite-tempered plain wares may be the unpainted precursor to the BPVs. Brown Paste Variants with South Mountain granodioritic temper from the Frank Luke Addition project were chemically profiled and compared to a sample of granodiorite-tempered plain ware manufactured in the vicinity of the east end of the South Mountain range. The results indicated that the clay fractions of each material were distinctive, and different from one another, and that the clay used to manufacture the BPVs was relatively homogeneous between the samples tested (Abbott 2016). These results should be considered along with the results of the petrographic analysis of Sample 1532 within this study, which showed that phyllite was present within that sherd in addition to grog and South Mountain granodioritic temper and it was hypothesized that the phyllite was introduced into that sample



through the addition of the grog. This finding may have implications regarding the chemical testing of ceramics that include grog. For example, if ceramic material was produced with grog derived from sherds with the same clay and temper, then it would be reasonable to suggest that the chemical composition of that material would be similar in grog and non-grog parts of the vessel's fabric. However, if the grog was derived from ceramic material manufactured in a different location, with different clay and temper, then reasonably, and depending on the mechanical treatment and level of pulverization of the grog material before its addition to the recipe, the resulting chemical signature would represent a mix between the clay and the added grog. This is an important point in the case of the chemically tested Frank Luke BPVs. If they included grog, then it is reasonable to suggest that the grog may have introduced foreign chemical material into those samples and that could have thrown off the results of their clay fraction's chemical analysis.

The SG-OSL dates presented within this study also help to support our inference that the early plain ware investigated during our study and the BPVs are related. Had the resulting dates included material produced only within the Formative period, then the argument could be made that early use of grog in the lower Salt River Valley was restricted to that time period, like the Agua Caliente phase material in Tucson, Arizona. And any subsequent grog use could have been construed as another technological tradition unrelated to its predecessor. Two sherds in this study that have SG-OSL dates match the period of greatest BPV production in the Phoenix Basin (Abbott 1998; Garraty 2016).

A review of the BPV sherds and partial vessels from the Frank Luke Addition project (Garraty 2016) showed that none of the BPVs from the project included grog within their pastes, although none were subjected to petrographic analysis, and grog was not a variable coded for within that study. During our current study, we conducted a review of five BPV sherds from an assemblage of 36,000 sherds that had been recovered from a recent excavation project we conducted within a portion of AZ U:14:49 (ASM), a Preclassic village in the Queen Creek area. Five sherds included South Mountain granodiorite temper as their primary tempering agent, and one recovered from a Santa Cruz phase pit house contained prominent pink grog (Garraty and Bustoz 2018). Five other examples are reported in the literature including two examples reported by Abbott (1998), recovered near Tempe Butte within La Plaza de Tempe, AZ U:9:165 (ASM), and three examples recovered at La Villa, AZ T:12:148 (ASM), which had their grog and South Mountain granodiorite temper identified through petrography by Ownby (2014, 2016).

The La Villa examples are important in drawing a connection between the early use of grog within the South Mountain granodiorite-tempered plain ware and BPVs for three reasons. First, their grog component is

indisputable because they have had that component proven through petrography. These were the only three BPVs which we could find that have been subjected to petrographic analysis. It is important to further note that of the material subjected to petrographic analysis from La Villa, these were the only BPVs analyzed, and all three (100% of the sample) were found to include grog (Ownby 2014, 2016). These crushed sherd inclusions, as we have established, are visually innocuous. It is possible that a large proportion of the South Mountain granodiorite-tempered BPVs contain grog and that it has been overlooked. Second, these examples represent artifacts produced with grog which cannot be discounted as temporally intrusive because they are decorated in the Middle Gila buff ware idiom. As locally produced, brown-pasted copies of buff wares, BPVs almost certainly had the same manufacture dates as their Red-on-buff analogs. Finally, since we have presented evidence for the use of grog in pottery manufacture within the lower Salt River Valley before AD 1170, further evidence for its use within another contemporary local ceramic ware should be viewed as equally aberrant and considered strong evidence of a probable relationship between the two ceramic materials. This point is based on the two ceramic materials sharing a production technique which was so rare for the time. In the case of our proposed relationship between the BPVs and the early grog-tempered plain ware, the probability of this relationship is exponentially increased since these well dated BPVs also were being manufactured with the same primary tempering material, South Mountain granodiorite. The weight of these results suggest that the early grog-tempered plain ware should be construed as the unpainted precursor to the latter BPVs, based on production trends, technique, chronology, and recipe.

These findings suggest the material tested within this study and BPVs are related to one another. Confirmation of this hypothesized relationship would require chemical testing via microprobe or neutron activation analysis of the clay fraction of a large sample of early plain ware and BPVs, as well as an analysis of the composition of their grog inclusions if present. If the results indicated that their clays are the same despite any chemical contamination attributable to grog temper, it would go a long way to account for the discrepancy between the clay fractions within the South Mountain granodioritic utilitarian plain ware and the BPVs found by Abbott (2016) and referenced above. Knowing this would provide further evidence that either they were being manufactured by different potters within the South Mountain Zone of Production or that the same potters utilized different clays and/or methods to manufacture the different classes of containers. Further, it would provide the final piece of evidence that the plain ware examined within this study should be construed as the unpainted precursor to the later BPVs. It would also suggest that the small-

scale production of non-buff ware ceramic containers produced away from the Middle Gila, but which bear nearly identical ideologically meaningful designs, also utilized grog temper. This should be considered as a subject for future research.

## CONCLUSIONS

Our luminescence and petrographic evidence show that early potters in the Phoenix Basin utilized grog in addition to local lithic materials in the production of ceramic containers, beginning at least in the mid-Red Mountain phase and continuing through the Pioneer period. This finding demonstrates that grog use in the production of pottery is not simply a Classic period phenomenon in the Phoenix Basin. From a practical standpoint, this means that the presence/absence of grog cannot be used as a ceramic attribute to identify Classic period and later contexts within the Hohokam Core. Finally, our study suggests early grog-tempered plain wares and later BPVs were manufactured in the same location using similar technology, despite their temporal separation.

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The Block 23 work was performed in accordance with an Arizona Antiquities Act project specific permit issued to Logan Simpson Inc. by the Arizona State Museum (2016-134ps), and the Block 23 Project was issued an Arizona State Museum accession number (2016-449). All materials recovered during the project are curated at Pueblo Grande Museum and all human remains and associated grave goods were treated in accordance with the stipulations presented within the burial agreement made with the Salt River Pima and Maricopa Indian Community.

**Data Availability Statement.** Data can be made available upon request by emailing the primary author at dbustoz@logansimpson.com

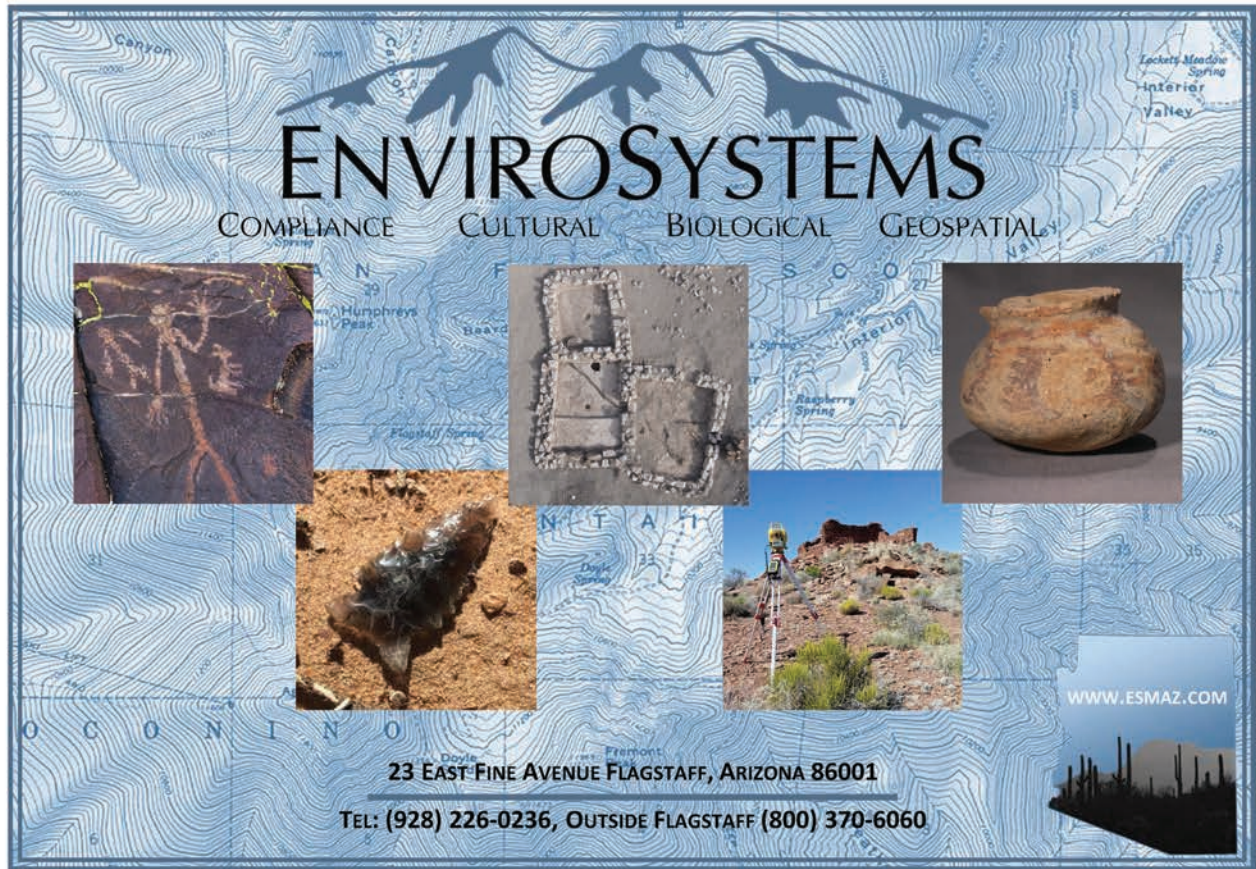
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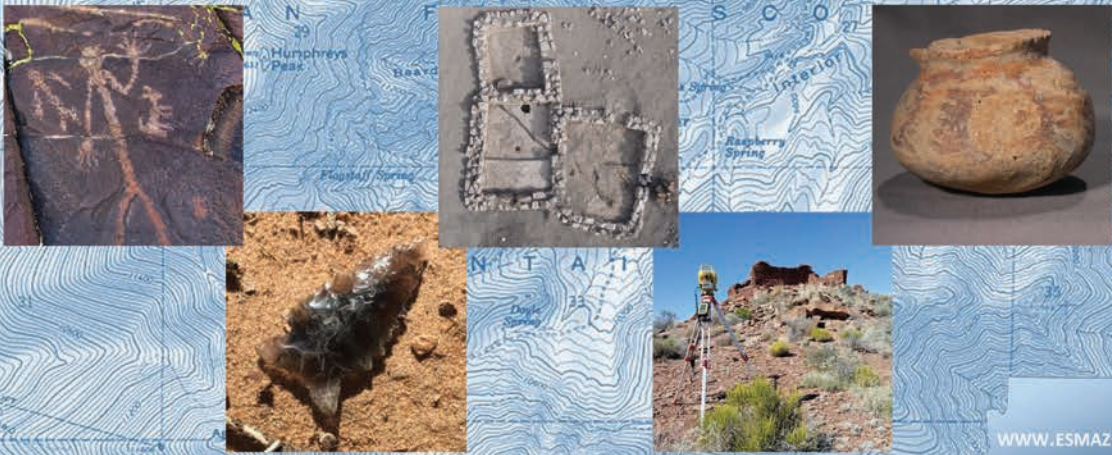


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Cover: Wupatki Pueblo South Unit, North Unit, amphitheater, and ballcourt, view to the northwest.  
Photograph by Alexandra Covert (2017).