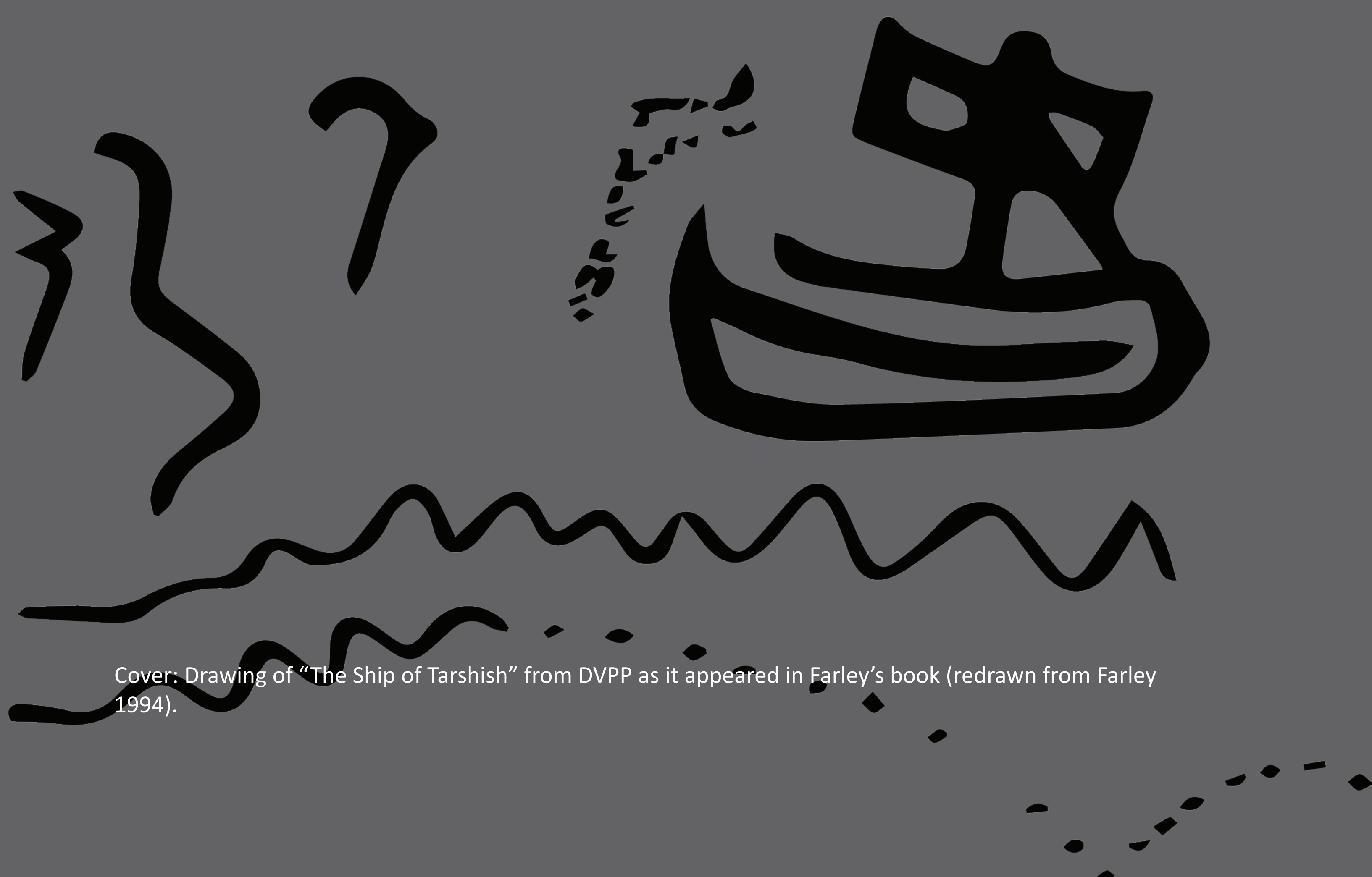
IN THIS ISSUE:



Cover: Drawing of "The Ship of Tarshish" from DVPP as it appeared in Farley's book (redrawn from Farley 1994).

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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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"HAVE YOU HEARD THE ONE ABOUT THE PUNIC SHIP IN THE SONORAN DESERT?" A CASE STUDY IN ADDRESSING ARCHAEOLOGICAL MISINFORMATION

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Alonzo Beatty
Katrina Lewis
Madeline Jo Maiorella
Ruby Sainz
Garrett Stanley
Kevin Stevens
Maya Street

There is a great deal of archaeological misinformation out there in the world and Arizona is no exception. In this article, we outline the history of pseudoarchaeological claims about the past in Arizona and the Southwest generally. We then describe our efforts to document the history of one claim regarding a petroglyph of a supposed Iberian Punic Ship that was said to have been left at the Deer Valley Petroglyph Preserve by people traveling from the Mediterranean in the ancient past. We debunk this claim (and related claims) by describing the many problems with interpretation and evidence. Using this case study as an example, we then explore recent research in social psychology and related fields focused on addressing the spread of misinformation and pseudoscience to develop a few principles that we suggest may be useful in addressing archaeological misinformation for public audiences.

"Can you take me to the ship petroglyph?" This project began innocently enough with this question by a visitor to the Deer Valley Petroglyph Preserve (DVPP), which was later relayed to Matt Peeples and Emily Fioccoprile by Chris Reed, a long-time volunteer docent at the preserve. Located along the eastern slope of the Hedgpeth Hills northwest of Phoenix, the DVPP is one of the largest concentrations of petroglyphs in southern Arizona (Figure 1). The petroglyph landscape includes over 1,500 individual elements, most of which fall along a 400-m stretch of east-facing basalt boulders recorded during an archaeological investigation conducted in advance of the construction of the Adobe Dam by J. Simon Bruder and colleagues with the Museum of Northern Arizona (Bruder 1983). The majority of the petroglyphs are associated with the Hohokam, Patayan, Archaic, and historic Yavapai traditions, and the site also contains some modern elements (often initials and years). Within Bruder's motif typology for the site (Bruder 1983:Figure 32) there are no ships or boats. One could spend days sifting through the extensive archive of photographs, drawings, full-size tracings and other materials from this project—curated at the DVPP—and never find a reference to a ship or anything similar, and Bruder herself was not aware of the supposed ship when asked in 2018 (J. Simon Bruder, email communication with Matthew Peeples, November 25th, 2018). To what, then, was our visitor referring?

In this article, we delve into the murky world of pseudoscience, fakes, frauds, and fringe science in the archaeology of Arizona to address the origins and spread of this ship story and other misinformation about the past. Fantastic claims about the history of Arizona are certainly not new, but as we illustrate, the spread of pseudoscientific ideas about the past and the proportion of people who believe such ideas have increased in recent years. Until fairly recently, this was an issue that the majority in the archaeological and historical community largely ignored while a relatively small number of dedicated scholars addressed such claims directly (see Feder 2006). We argue that it is increasingly important for archaeologists to be aware of the misconceptions and misinformation about archaeology, in particular in the areas where they work and intersect with the public. Using "the ship" at DVPP as a case study, we suggest some potentially profitable approaches that may help us curb the spread of such archaeological misinformation.

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Figure 1. The Deer Valley Petroglyph Preserve landscape in the Hedgpeth Hills in Glendale, Arizona.

Pseudoscience in Archaeology: We Have a Problem

Pseudoscience can be defined as ideas that purport to be factual and guided by scientific principles but which do not adhere to the scientific method or other tenets of logical reasoning (see Hansson 2017; Pigliucci 2013). Pseudoarchaeology is a more specific term used by many researchers to refer to interpretations of archaeological sites or artifacts that are not grounded in the principles of archaeological method or context (other related terms include fantastic archaeology, fringe archaeology, or alternative archaeology; [see chapters in Fagan 2006; Jordan 2001]). Defining the boundaries between science and pseudoscience is not always easy (Pigliucci 2010; Popper 2002; Sagan 1997) and archaeology is no exception. There are certainly instances of speculation and untestable ideas in the pages of respected archaeological journals (see Bahn 2006 for a particularly relevant discussion of the history of science and speculation in rock art research). Even when interpretations veer quite far from the confines of typical archaeological frameworks or represent outright frauds, non-specialists often have difficulty separating "real" archaeology from pseudoarchaeology. This difficulty arises in no small part because pseudoarchaeology is often "performative" (see Pruitt 2016) in that proponents take on the trappings of archaeological method, language, and scientific documentation (generating reports, using jargon, and even sometimes the selective use of tools common in scientific archaeology like radiocarbon dating). This performance often gives such work an air of legitimacy, and many proponents of fraudulent or demonstrably unsupported ideas are adept at using such perceived legitimacy to harness the media to great effect. As Tera Pruitt (2009) notes, however, simply labeling certain work as pseudoarchaeology does not deal with the complex academic and social forces that intersect in such claims or the reasons why they are or are not accepted by a broader audience. Effective approaches to addressing uninformed or misguided notions about the past would likely differ from approaches to addressing fraud and lumping all of these claims together has had the effect of most archaeologists ignoring the issue altogether.

Available evidence suggests that belief in pseudoscientific ideas about the archaeological past is increasing in prevalence. For example, since 2014 Chapman University has conducted an annual survey called the Chapman University Survey of American Fears (Chapman University 2018) designed to gather information on the fears, concerns, and attitudes of members of the US public. These surveys provide two statements directly relating to archaeology and ask respondents to "Strongly Agree," "Agree," "Disagree," or "Strongly Disagree": 1) Aliens have visited the Earth in our ancient past, and 2) Ancient advanced civilizations, such as Atlantis, once existed. The proportion of those surveyed that either "Agree" or "Strongly Agree" with these two statements have increased in the years available. Belief in ancient aliens increased from 20% to 41% and belief in Atlantis or other advanced civilizations increased from 40% to 57% of those surveyed. Notably the rates of belief in these ideas are higher than most other statements polled in the same category such as belief that bigfoot is a real creature, that fortune tellers can tell the future, that people can move objects with their minds, and that aliens have visited Earth in modern times. Belief in ancient aliens and Atlantis are most like the levels of belief reported in ghosts and guardian angels. Ken Feder (2006, 2017) notes that he has surveyed his undergraduate students periodically since 1983 and seen rates of belief in Atlantis and ancient aliens hovering between 10-30% with some fluctuations but no clear trajectory. It is particularly notable that this is among students who self-selected to take university archaeology courses. Feder's (2006) surveys included an option for students to respond "don't know" which consistently made up a large chunk of responses. Peeples has seen similar rates of belief at 13–36% for these same two topics (Atlantis and ancient aliens) among undergraduate students in upper division archaeology courses at Arizona State University between 2015 and 2019 in informal first day of class anonymous surveys completed by over 400 students (an average of 20.2% students somewhat or strongly agree with statements regarding evidence for the lost continent of Atlantis and ancient aliens across all years).

Some of the increased prevalence of reported belief in pseudoarchaeological ideas can likely be attributed to the frequency with which these ideas are encountered in contemporary media. There are far more television shows focused on dubious archaeological interpretations and pseudoarchaeology being produced to air on channels like the History Channel, H2, the Travel Channel, and the National Geographic Channel than there are shows focused on scientific archaeology (see Anderson 2018). Checking the book sales rankings on *Amazon* as of early 2020 many of the top selling nonfiction selections including the keyword "archaeology" are likely to make scientific archaeologists cringe with topics like "ancient lost civilizations," "aliens," and "human giants" leading the pack. As described by David S. Anderson (2019) there is a growing ecosystem of podcasts, YouTube channels, Facebook groups, websites, and even conferences catering to the fans of pseudoarchaeological content and the numbers of subscribers and viewers are astoundingly high compared to traditional archaeological professional organizations or other scientific content.

Faced with these trends, how have professional archaeologists responded to this wave of pseudoarchaeology? With some notable exceptions, the answer is that they largely have not (outside of the odd book review or special journal section). There have been a small number of dedicated scholars who have taken these issues head-on over the years including Ken Feder (Feder 1984, 2017) and Garret Fagan (Fagan 2006; Fagan and Feder 2006) and more recently they have been joined by researchers like the archaeologists Jeb Card and David S. Anderson (Card and Anderson 2016) and the writer Jason Colavito (Colavito 2020). There are also excellent blogs, websites, and podcasts that review pseudoarchaeological content from books to television and provide serious deconstructions of these ideas accessible to diverse audiences (Table 1). At the same time, there has been little response from the professional archaeological community or major professional organizations as a whole. Interestingly, this lack of a response differs from the professional response to other kinds of content such as television shows focused on buying and selling artifacts or metal detecting, which garnered greater initial response including widely circulated petitions and formal letters requesting action from the Society for American Archaeology directly to broadcasters (see Herr 2015 and other articles in special issue).

One sign that the tide of interest in addressing pseudoarchaeology is perhaps turning among professionals in the field is that a recent (November 2019) issue of the *SAA Archaeological Record* was dedicated to highlighting the current battle against bunk in archaeology (Anderson 2019; Card 2019; Colavito 2019; Feagans 2019; Hoopes 2019; Raff 2019). Importantly, many of the scholars who dedicate considerable effort toward confronting and debunking pseudoarchaeological ideas are also active on the platforms where these ideas spread like Twitter, Facebook, other social media, and podcasts.

The popularity of pseudoarchaeological ideas can be read several ways. It is hard not to see the steady to increasing rates of belief in interpretations of the archaeological record that are out of date or wholly rejected by the scientific community as anything other than a failure of public engagement and something we need to fix. Far more people are reading and consuming pseudoarchaeological content than scientific archaeological content and we are losing the battle for eyes and ears. The second angle from which one might view these data is that these trends suggest there is a large audience that is generally interested in archaeology and the ancient past and, if we were to find the right way to reach them, we could potentially find a new large public audience willing to support the field. The big question, of course, is how?

Pseudoarchaeology in Arizona

As is true of every region, there is no shortage of dubious tales centered on the history and prehistory of Arizona and the US Southwest. For the purposes of this paper, we highlight a few popular pseudoarchaeological ideas revolving around the origins of indigenous populations in the Southwest or the connections between the Americas and Eurasia and Africa prior to well-documented instances of trans-oceanic contact with the Norse settlement at L'Anse aux Meadows in Newfoundland and the subsequent arrival of Columbus. Such claims generally fall into what archaeologists have sometimes called "hyperdiffusionist" arguments suggesting that all (or most) major social and technological developments across the world are related to one or a few ancient civilizations (see Stengel 2000). Many of these ideas have their origins in the very earliest

Table 1. Blogs and websites that regularly engage in debunking or contextualizing pseudoarchaeological claims.

Name	URL
Andy White Anthropology	https://www.andywhiteanthropology.com/
Anthropology.Net: Beyond Bones and Stories	https://anthropology.net/
Archaeological Fantasies (blog and podcast)	https://archyfantasies.com/
Archaeology Review	https://ahotcupofjoe.net/
ArcheoThoughts	https://archeothoughts.wordpress.com/
Bones, Stones, and Books	https://bonesstonesandbooks.com/
Jason Colavito: Blog	http://www.jasoncolavito.com/blog
John Hawkes Weblog: Paleoanthropology, genetics and evolution	http://johnhawks.net/weblog/
Le site d'Irna	https://irna.fr/
Paleobabble	https://drmsh.com/category/paleobabble-2/
The Lateral Truth	https://www.skepticink.com/lateraltruth/

European historic accounts of the Americas. As Feder (2017:91–92) notes, as early as 1535 there were already accounts suggesting that the indigenous populations of the Americas were actually the descendants of lost European merchants or the followers of an ancient Spanish king. Thus, some argued that Columbus was not simply claiming the Americas but reclaiming them on behalf of earlier Spaniards. In 1552 via Francisco López de Gómara we see the earliest reference to the Americas being the mythical island of the Atlantis that Plato first wrote about in his dialogues (Feder 2017:163). Although there is considerable evidence that Plato wrote these descriptions as philosophical illustrations rather than literal accounts (Dunšanić 1982; Rosenmeyer 1956), people have tried to place Atlantis in the real world for centuries. Claims in this vein remained popular in the intervening years and the expansion of European colonies and later US settlers across the Americas.

In the early nineteenth century, numerous new claims began to emerge suggesting connections between the Americas and the Near East and other locations in Eurasia. Many such claims suggested that American cultures were related to the lost tribes of Israel or events described in the Book of Mormon (first published in 1830). This new wave of claims also was associated with several archaeological finds of dubious context or outright forgeries (stones with apparent inscriptions in Hebrew and other languages, etc.) that were initially presented as material evidence of connections between the Old World and the New World (see Colavito 2020). In more recent years, we have also seen no shortage of claims of trans-oceanic contact between the Americas and numerous locations across the world prior to documented instances of contact. Many of these arguments recycle Victorian-era racist ideas of indigenous populations in the Americas as incapable of civilization and they often attribute cultural achievements of Native Americans to outsiders from other ancient (and perhaps lost) cultures (e.g., Fell 1976; Hancock 2019; Van Sertima 1976) or even aliens (von Däniken 1968). Troublingly, even if this is not the intent of authors, these ideas frequently intersect with and fuel extremist ideas connected to White Nationalist and neo-Nazi groups in the Americas and elsewhere (Bond 2018; Zaitchik 2018).

Perhaps the most famous and well-documented hyperdiffusionist claim of trans-oceanic contact with Arizona revolves around a set of artifacts generally referred to as the Tucson artifacts or the Silverbell Artifacts. These objects, encountered in an abandoned limekiln on the northwest side of Tucson in 1924, consisted of a series of lead crosses, spears, and other objects with text in Hebrew and Latin and images (even including a dinosaur!) engraved on them. These objects were initially reported as evidence of a Jewish-Roman colony in Tucson between AD 775 and 900 and they were such a sensation they made the front page of the *New York Times*. Don Burgess (2009) has written an excellent account of these artifacts, the controversy around them, and the substantial evidence that they are forgeries (from Latin texts copied from textbooks to the archaeological and geoarchaeological context to historic letters referencing the objects). Despite the serious problems with these finds that are readily apparent now, in the 1920s Byron Cummings and others at the University of Arizona took the finds seriously enough to conduct excavations and even consider a purchase of the site where they were recovered. By 1930, however, whatever support these objects might have initially had from the scientific community appears to have largely evaporated as they were rejected as fakes by Cummings and others in their final assessment due to problems with the texts, the materials and technologies used to make the objects, and the archaeological context. As Burgess (2009) notes, although there is plenty of evidence that these objects were fakes, there is still considerable ambiguity in terms of who may have been responsible for producing them. Despite the mountain of evidence that the objects were hoaxes, as recently as 2016 fringe publications like *The Epoch Times* (MacIsaac 2016; *Epoch Times* was recently banned from Facebook due to misleading political advertising [Alba 2019]) and *Ancient Origins* have run stories suggesting that the Tucson artifacts are authentic.

Another series of popular claims with connections to Arizona comes from the publications of Harvard marine biologist turned amateur prehistorian Barry Fell. In the 1970s and 1980s Fell (1976, 1980, 1982) published a series of books purporting to show evidence that, among other things, the Americas were colonized about 3,000 years ago by Iberians from Spain and Portugal or perhaps other Mediterranean cultures. Fell claimed to have found Bronze Age Punic, Celtic, Libyan and other scripts in geometric designs of petroglyphs across much of the Americas. He further claimed to be able to decipher them. Fell proposed a massive trade of copper, fur, and other raw materials between the Americas and Europe and Africa suggesting frequent trips by ship across the Atlantic Ocean (Fell 1976:93-110). Although he is often described as an epigrapher, Fell had no formal training in epigraphy or prehistory and has been widely criticized by experts in these fields for making fundamental mistakes in his interpretations and translations and for the use of poor quality material cultural evidence (e.g., Goddard and Fitzhugh 1978; McMenamin 2000; Stengel 2000). Among the many claims made in these books Fell (1976:172) suggests that certain songs in the Pima language (O'odham) of the Sonoran Desert within the Uto-Aztecan language family can be read using a "Semitic" dictionary. He further claims that the Zuni language (a linguistic isolate; see Hill 2007) was descended from a poorly known Libyan language family (Fell 1976:175). He uses these supposed linguistic connections to attribute cultural developments in the US Southwest to migrants from the Mediterranean. These claims were immediately rejected by archaeologists and linguists working in the area including a review published by the Department of Anthropology of the Smithsonian Institution that outlines the serious problems with the linguistic claims suggesting that Fell has no knowledge of the grammatical rules of the American Indian languages he claims to connect to Europe and Africa (Goddard and Fitzhugh 1978; see also Feder 1984). Despite this, Fell's ideas remained popular in certain fringe circles, in large part due to the Epigraphic Society organization which Fell founded to publish occasional papers on epigraphic analyses often veering into the fringe and certainly not representing a source widely used by academic linguists. We will return to the claims of Barry Fell and his disciples in the case study below.

In more recent years, there are almost too many claims to enumerate. We could add to the list those ranging from the recently revitalized claims based on a 1909 hoax published in the *Arizona Gazette* that the Smithsonian Institution has been hiding evidence that Ancient Egyptian, Tibetan, and other Old World remains were found in a cave in the Grand Canyon (see discussion in Colavito 2013) as well as publications by John Ruskamp Jr., who claims to have identified Chinese writing in petroglyphs in the Southwest (Ruskamp 2013; see Quinlan 2015 for an archaeological criticism) for an archaeological criticism). Arizona has also featured prominently in pseudoarchaeological content on television with claims of lost Anglo-Saxons in Arizona (*America Unearthed,* season 1, episode 2; see Williams 2015 for a thorough debunking and Medrano 2020 for a popular account in *Arizona Highways*) or alien visitors to the Hopi Mesas (*Ancient Aliens*, season 5, episode 4). In addition to these claims for such trans-oceanic (or even trans-galactic) contact, Arizona and the Southwest are also often implicated in what we might call "catalogs of evidence." A common format in the world of fringe archaeology is to present a long list of supposed evidence for a claim, providing little to no context for each individual piece of evidence and inviting the reader to make up their own mind. The sheer volume is designed to make the point where specific information is lacking (for example see Handke 1978). It is in one of these catalogs of evidence that our case study for this article originates (Farley 1994). In the discussion below, we see what happens when we start to pull the thread on a couple of items in such a list of claims.

Case Study: The Ships of Tarshish?

So, what was our visitor talking about when he asked to see the ship at DVPP? After a bit of digging and searching on the internet, we eventually located the likely source of this question. In 1994, Gloria Farley self-published a book called *In Plain Sight: Old World*

Records in Ancient America. In this book, Farley outlines work that she conducted over the course of nearly 50 years to document inscriptions and drawings that provide evidence of ancient visitation to the Americas by populations other than indigenous Native Americans. After working alone for many years, Farley eventually connected with Barry Fell prior to the publication of his first major book and the two apparently worked closely together over the years as colleagues and friends. Indeed, Barry Fell's son Julien Fell wrote an obituary for Gloria Farley when she died in 2006 noting her special relationship with his father (Fell 2006).

Much of Farley's work focused on Oklahoma and adjacent areas, and in particular the Heavener Runestone from her own hometown. The Heavener Runestone is a purported Norse runic inscription with characters in Elder Futhark (a writing system from northern Europe that predated the Viking era). Farley and others have suggested it is authentic evidence of a Norse presence in Oklahoma while other archaeologists and epigraphers have suggested it is more likely a nineteenth century carving due to differences in ornamentation, problems with the translation (which probably reads Gnome Dale), and the lack of any other material evidence for a Norse presence in the area (see Lovett 2015). Despite all of this, Gloria Farley was a key player in getting the Heavener Runestone area declared a state park, which was later transferred to the City of Heavener in 2011 and now run by a local non-profit. The park is now the location of an annual Viking Festival and fund raiser.

Much of Farley's (1994) work is focused on contextualizing the Heavener Runestone and other purported inscriptions in the region by drawing on references to many other similar potential examples from across the Americas. One of the book's chapters, entitled "They Came in Ships," presents her thoughts on the potential ocean and river pathways that ancient sea farers would have taken to reach the interior of North America. This also includes a catalog of 24 supposed ship petroglyphs from throughout North America. Farley argues that many of these potential ships show features that are common in Old World ships as well as other seafaring technology. With two exceptions these are presented as drawings with text descriptions (two are also shown with photographs).

Among these many examples is one labeled "The Ship of Tarshish." This is a reference to Barry Fell's (1976:93-110) book *America B.C.: Ancient Settlers in the New World* and his discussion of a Bronze Age Iberian city in what is now Spain (elsewhere referenced as being in North Africa) called Tarshish or Tartessos, which was known for producing large seagoing vessels. Fell describes a petroglyph and inscription in Rhode Island, which he claims shows a boat and an inscription that read "Mariners from Tarshish this stone proclaims" before it was vandalized (thus destroying the text and any chance of investigating this claim further). Farley's (1994) reference to a ship of Tarshish comes from a letter she received from Lyle Underwood of Tucson, Arizona. She published an excerpt of an undated and unpublished manuscript by Underwood stating:

> "Here we have two wavy lines of ocean upon which sits a two-decked ship with rectangular sail. Backstays for the mast are shown, but no forestays. To the left of the ship we find some abstract symbols. Identified by Dr. Berry Fell as South Iberian Punic, the letters are '**S S-F-N.**' The Punic has no '**F**' and like the Hebrew, uses a form of '**P**' to create the '**F**' sound. Modern Arabic does have an '**F**' and would have spelled this as '**S S-F-N**' which is '**ES SAFN,**' or in English, '**The Ship**.' So we have here a drawing of a ship on a rock and caption which identifies it as '**The Ship,**' there being no question as to the intent of the artist. This inscription has been 'core sampled' by archaeologists who have carelessly allowed the borings to dribble down the face of the rock and dry like cement. Why they did not wash this off while it was still wet is to their eternal shame. Here on the Arizona desert is a pre-Columbian carving of a ship. Evidence pure and simple of perhaps many pre-Columbian voyages, is it to be destroyed?" (Farley 1994:31; quoting Underwood, bold in original).

This excerpt is accompanied by a drawing which Farley says was traced from the photographic enlargement provided by Underwood but she also says that Underwood "found and sketched the entire petroglyph before the archaeologists' damage was done" (Farley 1994:31). It is not clear if details from Underwood's drawing that were invisible in the photographs were incorporated into the drawing published by Farley (see Figure 2).[1]

The text from Underwood makes a series of arguments that need to be unpacked. First, he suggests that the image clearly represents a boat with identifiable features related to a seagoing vessel. Next, he suggests that the symbols represent a clear statement "The Ship." It is not readily apparent if Fell provided the translation or simply identified the script as South Iberian Punic. Finally, Underwood accuses the archaeologists of being careless and perhaps even intentionally destroying evidence of pre-Columbian voyages.

With the information above in hand, our team then set out to discover what we could learn about this claim

Figure 2. Drawing of "The Ship of Tarshish" from DVPP as it appeared in Farley's book (redrawn from Farley 1994).

by studying the DVPP archives and the site itself. We started by examining the archives for the core-sampled petroglyphs from the project. This sampling was part of a dating experiment designed to test the viability of hydrogen profile analysis (Taylor 1983). After searching through drawings, tracings, and photographs, we were eventually able to find the inspiration for the drawing published in Farley's book (panel I110A; DVPP Archives). Although this panel is not listed in Taylor's hydrogen profile analysis report, an archival drawing of the petroglyph panel shows that two of Taylor's core-samples, samples 016 and 017, were collected on and adjacent to the petroglyph identified by Underwood and Farley as a ship. Taylor (1983:292, 296) notes that five samples drilled from petroglyph panels could not be used; only those that survived this destructive method and yielded data are listed in the table of results (Taylor 1983:297, Table 25), and samples 016 and 017 are conspicuously absent suggesting that these did not yield usable data.

As Figure 3 shows, there are some key differences between Farley's (1994) published drawing and the photographs and drawings of panel I110A in Bruder's (1983) report and in the DVPP archives. To resolve these inconsistencies, we returned to the site, located the boulder in question, and photographed and filmed it to make a 3D photogrammetric model (Figure 4; see Peeples 2020 to view the interactive model). In Bruder's original recording, the large set of lines at the right side of the panel, which Underwood and Farley call a ship, are classified as a possible winged insect (Bruder 1983:243, Plate 24). Notably, the wavy lines which Underwood interpreted as the ocean do not continue under the insect/ship petroglyph as they do in the drawing in Farley's book; instead, the latter extends downward past the wavy lines. On the left-hand side of the panel, we can see abstract shapes that are somewhat similar to the "letters" depicted on Farley's drawing. Notably, however, these lines are far less distinct than they are presented in Farley's drawing, and it is unclear why some potentially modified surfaces were drawn while others were not. Comparing photographs in the archives, we also determined that the boulder on which this panel is found fell downslope several feet sometime between 1993 and 2018. In addition to the core-sample marks, there are also other damaged areas of the surface which appear to be bullet marks (unfortunately

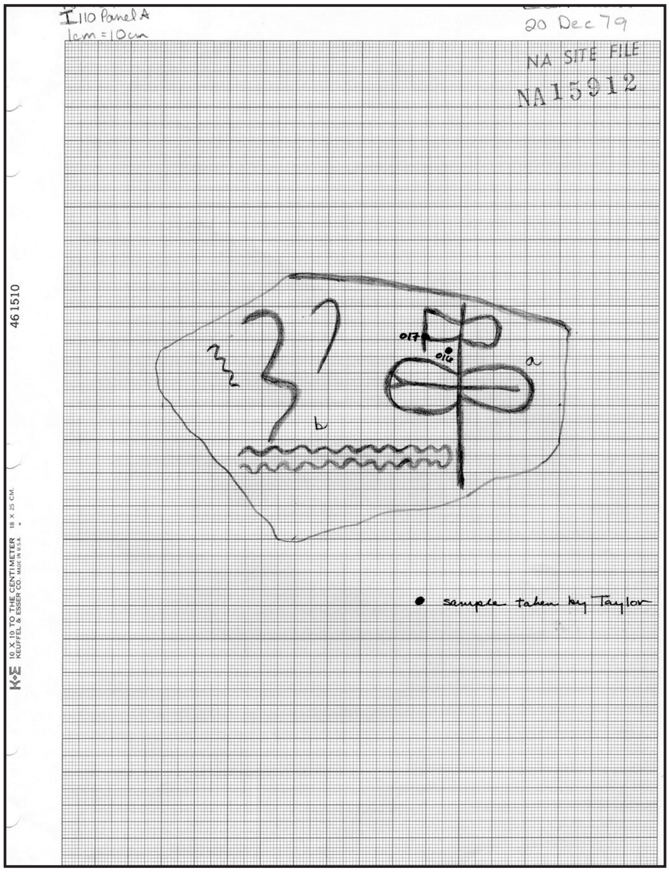

Figure 3. Original in-field drawing of DVPP panel I110A showing core samples taken by Taylor.

common at DVPP), which were also visible in the 1979 and 1980 archival photos.

Turning to the features claimed to be an inscription reading "The Ship," there are several issues—apart from the simple lack of clarity and distinctness in the lines—that make this interpretation strained. Specifically, the supposed translation includes the letter "S" twice, but the abstract markings do not appear to repeat. Beyond this, even if we take the drawing at face value, in order to interpret this as S-S-P (or F)-N as the text claims, we would need to allow for variation among two letters claimed to reference the same character (S), additional unexplained lines in another character (P), and finally that the final supposed character (N) that is so faint on the surface it was even drawn with dotted lines in Farley's (1994) book is reversed (compare to Punic letters in Diringer 1953:237). This is certainly a stretch and a far cry from the quite clear Iberian Punic inscriptions found in Europe, where letters are unambiguous and distinct. Indeed, the abstract shapes on this boulder are typical of many of the petroglyphs in southern Arizona and in the remainder of DVPP. If this was someone's attempt at writing "The Ship," it was not a very successful effort.

Next, Underwood suggested that the core-sampling process resulted in material drying on the surface "like cement." It is unclear what Underwood may have encountered as there are archival photos from the 1979-1980 project after the sampling was done with the core-samples visible but with no material on the face of the boulder. We have found that suggestions of archaeological conspiracy and cover-up are common in interpretations of archaeological evidence outside of the mainstream and are often used to deflect criticism, but without access to Underwood's photos it is hard to know what to make of his statement.

Finally, and this may go without saying to an archaeological audience, if there really were Iberian Punic seafarers in Arizona 3,000 years ago, then where are all the artifacts? As they say, absence of evidence is not evidence of absence. At the same time, later European *entradas* into the Americas certainly left a visible mark. Coronado's journey through the Southwest is dotted with caret-headed iron nails, crossbow bolt heads, horseshoes, and other objects dropped like a trail of breadcrumbs. There is similar evidence in the Southeastern United States along the trail of Hernando de Soto. If enough Iberians were here that, as Fell (1976) claims, the Pima language was connected to Semitic languages from the Mediterranean, then it begs credulity to suggest that there would be no other physical remains left behind.

What can we do about it?

Perhaps some readers are scratching their heads at this point. Did we really just spend several pages addressing such an outlandish claim? Is anybody really fooled by this stuff? Sure, to someone versed in the archaeology of the region or archaeological method and theory generally, it is easy to dismiss such fantastical claims as obvious misinterpretations, wishful thinking, or just downright ridiculous. The problem, however, is that people who do not have a background in archaeology often have no frame of reference to interpret claims like this. As Feder (2006) notes, most people who encounter such ideas are not the "true believers" dedicated to identifying trans-oceanic contact and archaeological conspiracy, but instead "fence sitters" who entertain such claims as possible without deeply engaging. These people are the majority that we need to try to reach.

Before we went through the process of tracking down information about the DVPP ship as outlined above, when our volunteer came and asked about it the only answer that we could offer was, "We're not sure what you're talking about." This would certainly be less than satisfying to an interested visitor, and perhaps further proof of a conspiracy to some. We conducted this research because we wanted to be able to answer this

Figure 4. Photograph of DVPP panel I110A. The top image is the original photograph and the bottom photograph was edited in ImageJ using the DStretch extension (Harman 2009) to emphasize petroglyphs.

question, but even with the information above in hand, it is not entirely clear how to best convince a general public that there is a difference between real archaeology and the kinds of wild interpretations that we have covered here. In the remainder of this article, we briefly turn to the literature focused on conspiracies and the spread of misinformation in social psychology and related fields to try to glean an answer.

Studies focused on how and why individuals believe things not backed up by empirical evidence suggest that people come to such beliefs for many reasons that have little to do with a logical weighing of evidence (see Scheufele and Krause 2019). There is little evidence that suggest intelligence or general cognitive ability (however measured) is strongly predictive of belief in pseudoscientific ideas. Further, although education and scientific training are negatively correlated with belief in pseudoscientific ideas, the changes observed over the course of a college education for individuals are small ([and smaller than initial differences between science and non-science majors] see Impey 2013). Indeed, people with more education tend to actually be more polarized in their beliefs, especially around controversial topics (Drummond and Fischoff 2017). There is, however, some evidence that the degree to which an individual values rationality may mediate relationships between cognitive ability and unfounded beliefs (see Ståhl and van Prooijen 2018). Belief in things like undemonstrated conspiracies also may be related to other kinds of individual values and attitudes. For example, the self-reported predilection of an individual to participate in a conspiracy on their own is predictive of belief in conspiracies generally (Douglas and Sutton 2011). As this suggests, there is compelling evidence people do not believe pseudoscientific ideas because they are cognitively limited or uneducated, but rather because of the complex ways specific beliefs intersect with their own identities, values, and attitudes.

In light of the work outlined briefly above, there is a growing literature in social psychology focused on how to best correct misconceptions given that such ideas are often tied to identities and values. One common and seemingly attractive (on the surface at least) strategy for correcting misinformation is simply supplying factual information to replace it. Unfortunately, this can often have unintended consequences. Psychologists describe a "backfire effect" that occurs when misconceptions are addressed by simply presenting new facts to replace them without context. Over the course of hours, days, and weeks, there is substantial evidence that many people will simply remember misinformation as true and vice versa, especially when they have limited experience with the topic at hand (e.g., Nyhan and Reifler 2010; Peter and Koch 2016). Indeed, misinformation is often recalled more readily than factual information as surprising ideas (whether right or wrong) are often retained due to their novelty. In the medical arena, there have been studies exploring how people respond to information combating myths about vaccines. In one such study, a common "Flu Myths vs. Flu Facts" flyer was shown to patients and individuals were asked to recall information at several temporal intervals later. This study demonstrated that such an approach actually reinforced and increased the prevalence of ill-founded beliefs, doing more harm than good (Pluviano et al. 2017). We do not want to discourage effort in this respect, but it seems the archaeological myths vs. archaeological realities memes we have seen floating around on social media are unlikely to be effective.

Fortunately, there are several approaches for which there is evidence of effective corrections of misinformation. Importantly, different approaches are well-suited to different contexts where we might encounter misinformation about the archaeological past. First, there is strong evidence that teaching critical thinking skills in a classroom context has a significant impact on the belief in pseudoscientific ideas (McLaughlin and McGill 2017). Work in this vein suggests that effective teaching needs to not simply deliver facts but focus on the history and epistemology of those ideas. Such teaching should ask and answer the question "How do we know what we know?" Beyond this, there is evidence that teaching students strategies that are frequently used to mislead (or by which people frequently mislead themselves) can help to "inoculate" individuals against beliefs in unsubstantiated claims (e.g., Banas and Rains 2010). There is a growing literature focused on psychology in the public arena that suggests knowing the source of biases can help to predict the most likely effective strategy to combat misinformation (Lewandowsky et al. 2012). Thus, part of the solution to combating archaeological misinformation may be to proactively produce content that addresses common pitfalls in archaeological interpretation to help prime members of the public for critical thinking.

The strategies above suggest some effective approaches when dealing with students in a classroom setting or other arenas where there may be an extended interaction with the public, but what about the short-term and ephemeral interactions we have with members of the public? Dealing with misinformation in such limited-contact situations can be more difficult, but a recent meta-analysis suggests a few promising approaches (Chan et al. 2017). Some recommendations offered in relation to this body of social psychological research suggest that a successful correction of misinformation typically directly assesses claims made in sources of misinformation in ways that foster conditions for scrutiny and counterargument by the listener. Specifically, if people can be led towards counterarguments on their own, the debunking effect tends to be stronger and misinformation less likely to persist. Beyond this, there is evidence that the level of detail in the debunking message is important. Generally, a debunking that simply says "it isn't so" is not likely to be effective. A more detailed debunking that addresses many aspects of the source of misinformation tends to produce a stronger debunking effect. Notably, such a detailed debunking can sometimes backfire if an individual is predisposed to view the misinformation positively, so it is also important to know your audience. Finally, there is considerable evidence that when scientific information, including attempts at debunking misinformation, is delivered using narrative formats and storytelling, information is often better comprehended by non-specialists and thus, such efforts may be more persuasive (see Dahlstrom 2014).

We certainly do not suggest that there is a one-size-fits-all answer to addressing archaeological misinformation. We also argue that there is a great need for research that directly addresses the ways in which people form, retain, or change ideas about archaeology and the past generally to complement research on other well-studied topics like medicine and climate change. From the literature briefly outlined above and our own experiences in this case study and in teaching such topics generally we can generate a few suggestions. First, we suggest that it is important to be aware of the common misconceptions regarding the archaeological contexts or regions you study and be prepared to address them when they arise. If you know what the bad arguments are, you will be better prepared to answer questions in a productive way when asked. Further, when debunking claims, be as specific as possible and try to help your listener draw conclusions from the evidence you produce rather than just telling them what they have heard is not true. For example, in our DVPP case study, we have found it helpful to show people examples of real Punic writing and the Punic alphabet as well as other abstract geometric features present at DVPP. Most people start to draw the conclusions we outlined above on their own, which we hope strengthens the debunking effect. Finally, try to tell a story. We have found that providing a detailed history of where a piece of misinformation originated and all of the players involved over time can provide a story that members of the public find compelling, and hopefully, one that will help them remember the details of the debunking. In our DVPP case, this includes discussing Barry Fell and Gloria Farley, and the relationships among their work and older Victorian and contact-era ideas about the ancient Americas. Importantly, all of these approaches require that archaeologists familiarize themselves with what is happening in the world of fringe archaeology in their own backyards and beyond.

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ENDNOTE

1 Portions of Gloria Farley's (1994) book are reproduced on her website, though some of the images and captions on the website are incorrectly reproduced from the print book. This includes the DVPP petroglyph that is the subject of this article. The image that appears online (http://www.gloriafarley.com/chap2.htm) captioned "Fig. 2-36 A ship petroglyph, Arizona. Redrawn from photograph by Lyle Underwood" is actually the image in the print book described as "Fig. 2-37 The Vernal Ship Petroglyph, Vernal, Utah." The original image of the ship that is the subject of this article is not included on the website. A hard copy of Farley's book is available in the Arizona State University, West Campus Fletcher Library and other publicly circulating libraries.

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PATTERNING IN PRE-CLASSIC HOHOKAM VILLAGE STRUCTURE: IMPLICATIONS FOR CULTURAL RESOURCE MANAGEMENT

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Hohokam settlements of southern and central Arizona have been the focus of nearly 40 years of intensive field investigations and yet there are still major gaps in our knowledge of village structure and organization. New maps of extant Hohokam villages dating from approximately AD 800 to 1050 (including many never previously mapped) are compared to data from villages that have received large-scale excavation to identify commonalities in structure. Structural units consisting of plazas surrounded by suprahousehold groups and their associated cemeteries, refuse deposits, roasting facilities, and ball court(s) are found to be the basic universal social unit which is replicated on larger villages. Some patterning in the specific arrangements of these structural units was identified, as were patterns related to the length of occupation. Findings of the study are considered for their implications in cultural resource management investigations.

From 2016 to 2018 the authors visited and mapped surface features at Hohokam ballcourt villages in southern and central Arizona with the goal of elucidating their organizational structure when taken with data obtained from intensive excavations at a range of sites. Our focus is on the span of time from approximately AD 800 to 1050. We plan to publish details of this endeavor elsewhere. In this report, we summarize some of the highlights of the study and provide a full set of site maps. The investigation identifies a series of commonalities in pre-Classic village structure that are relevant to cultural resource managers and contractors, enabling more efficient and comprehensive excavations.

Previously excavated villages with data considered here include Snaketown, Valencia, La Ciudad, Gila Crossing, Sleeping Snake, Honey Bee, Water World, the Anamax Ballcourt site, Redtail/Silverbell-Coach line[1], Ironwood Village, and to a lesser degree, Citrus, Gatlin, Hardy, Meddler, and Los Morteros.[2] From the previously excavated settlements, it was clear that plazas are typically present, surrounded by cemeteries, residential areas, and mounds in their inner precincts. Ball courts typically were present either adjacent to the plazas or immediately outside the ring of mounds surrounding them, although exceptions occur. These and other structural components were considered in light of the surface-mapped villages.

Villages in this study are defined on the basis of evidence of substantial momentary population and public architecture. On a practical basis, we limited our field investigation to those with ball courts. In most instances, a village, as defined here, was found to be composed of one or more plaza groups with each plaza group consisting of a central plaza surrounded by residential areas, cemeteries, mounds, and usually a ballcourt. Some unexcavated sites we visited and excluded from consideration appeared to be villages due to the presence of numerous contemporaneous mounds and in some cases even had definable plaza groups but lacked surface indications of a ballcourt. In those with definable plaza groups, in each instance portions of the area around and within the mound groupings were disturbed by modern features such as roads, thereby preventing us from knowing if a visible court had been present. However, it is possible that courts are present in some of the locations where they are not visible on the surface such as the one discovered recently at the Park Link site, AZ BB:8:20[ASM],

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Garraty et al. 2020). In all such cases, ball courts may be present but are either destroyed or are not visible through surface inspection. Also, there are a number of villages we visited with ball courts that did not have surface mounds or only had a very limited number, limiting our ability to discern site structure. These cases were excluded. Future work mapping artifact surface densities could be done to evaluate structure.

When mapping the villages considered here we focused on the major visible surface features including mounds, ballcourt, hornos (pit ovens) and other roasting features, Classic period component surface architecture if present, and plazas. Plazas were identified by patterning in mound distribution (rings of mounds), surface inspection for gaps in artifact scatters, and for cases where there were subsurface deposit exposures such as animal burrows and erosion channels, a void in artifact distribution was sought. For two cases, Granite Knob and Valencia, surface vegetation differences marked plaza areas (presumably from harder-packed soil or plastering). Also, the plazas at Redington were identified due to prehistoric clearing of surface rock where they occur. In many cases, additional plazas other than those indicated on the maps seen here may be present, but we lacked sufficient evidence to be confident. Based on excavated sites where plaza sizes are known, we started with the assumption that plazas have a minimum diameter of 35 m, and on a practical basis, with the possible exception of the Anamax Ballcourt site, the excavated cases had plazas substantially larger than this. Furthermore, the only other type of open space found at pre-Classic Hohokam villages that is enclosed by habitation and other features are plazuelas (discussed below) and courtyards, and both of these types of space are smaller than 35 m in diameter.

As plazas have not been consistently identified from surface indications alone in prior studies, we understand that there may be some skepticism in the identifications here. To be clear, we did not simply look for rings of mounds. If that were the approach, many plazas would be identified, and we are certain many would be bogus. Based on known excavated cases, we started with the assumption that the largest mounds at a site are most likely near a plaza (because these are the locations with the most desirable residential space over time). Snaketown and Honey Bee are good examples in this regard. Although large mounds are occasionally located away from plazas, if one finds a concentration of such mounds, they are likely to be adjacent to one, they are likely to be adjacent to one based on these cases. This knowledge, admittedly based on a limited number of cases, when combined with other data, helped identify likely plazas. Other than in a few cases where surface artifact densities had been mapped, we did not map these distributions. Instead, we canvassed sites and watched for patterns in artifact distribution as they related to potential plaza areas based on other criteria such as mound size and distribution patterns. As artifact density might be lower between mounds at sites, comparison between possible plaza spaces and non-plaza spaces was necessary. This process was subjective because we did not quantify artifact densities, but given the notable differences in most plazas, we were generally confident in our assessments. It should be noted that in some cases, possible plazas were identified after mapping was completed. In these cases, we revisited sites to inspect the surface artifact distributions to see if our assessment was accurate. In some cases, we were uncertain due to ambiguities in mound distributions, artifact patterning, or other factors. In these instances, plazas are shown with a question mark on the maps. Also to be noted, the precise limits of plazas could not be identified in any of the unexcavated cases so one should not assume accuracy for dimensions on the maps. Methods for working with plaza dimensions are discussed in a companion article based on Wallace et al. (2020).

Terminology used was introduced in Wallace et al. (2020). Plazuela groups and plazuelas are notable additions/changes to the Hohokam lexicon. *Plazuela groups* are what were formerly called village segments by Henderson (1986, 1987) and Wallace (1995), residential units by Howard (1990), structural complexes by Sires (1984), and house cluster aggregates in a later publication by Sires (1987). They were introduced to the literature by Lindeman (2015:417) and Craig and Woodson (2017) due to the conflicting interpretations of the term 'village segment' (e.g. Howard 1990, 2000; Wallace 1995). As discussed in these studies, they are suprahousehold groups, composed of two or more courtyard groups that are most often thought to represent descent groups. Plazuela groups are not just building blocks of villages, they are also found as discrete units which are then called hamlets. The open space within or adjacent to them are called plazuelas. They were generally not identifiable through surface observation although several possible plazuelas were found on the surface-mapped sites.

Plaza group is also a term not in common use. We use it to designate a plaza and all of the mounds, hornos, residential areas, cemeteries and other features that form a ring around the plazas on sites where the topography does not distort the layout. When plaza groups occur in isolation they are viewed as small villages.

We did not attempt to map all artifact concentrations, middens, rock clusters, and other features that did not aid in assessing the large-scale aspects of settlement structure. As a result, the maps should not be used for the purposes of cultural resource management (CRM) other than at a general level.

MAPPED VILLAGES

Thirty-five Hohokam villages were fully or partially mapped for this study and data from ten fully or partially excavated villages were examined to aid in the interpretation of the surface mapped villages (Table 1). By necessity, only those sites with visible mounds are included as we did not have the resources to map surface artifact distributions or conduct test excavations. The sample includes a wide range of village sizes and covers a broad geographical area including sites from the Tucson and Phoenix areas as well as outlying regions such as the lower Verde, San Pedro, northern periphery, and Gila Bend. Figure 1 provides an overview of the distribution of sites included.

In several cases, we revisited settlements that had been partially excavated and we mapped additional surface features that were not reported in prior publications. Such cases included the KEG site, Buttes Dam site, and Maricopa Road site. Several of the villages had not been previously recorded. Only settlements with preserved ball courts were included in the sample we mapped.

During our canvassing of the sites we noted temporally diagnostic artifacts to assess the temporal span of the settlement, whether there were differences across the site, and to assess the ball courts and plaza groups associated with them. Some sites, especially those in the upper Queen Creek area, had very few decorated ceramics on the surface, limiting our ability to assign date ranges.

The settlements vary considerably in their occupational histories (see Table 1). Some were inhabited for most of the Hohokam sequence, while others date only to one or two phases. Not surprisingly, these differences have an effect on the observed village structure. Some of the larger villages began as small to moderate size settlements that became much larger in the Sedentary period when entire plaza groups (probably other small villages) coalesced with them. This was the case for Azatlan in the lower Verde and we suspect it was the case for many of the largest settlements in the Gila Bend area.

SUMMARY OF RESULTS

Figure 2 illustrates the basic village structure template we identified. Our study is not the first to present a model of pre-Classic Hohokam village structure. Wallace (1995:763–774) reviewed the history of village structure work in the Hohokam region. There is widespread agreement among Hohokam researchers that, for at least the post-early Pioneer period, courtyard groups are the basic building blocks of villages (e.g. Doelle et al. 1987; Henderson 1986, 1987; Howard 1985; Sires 1984; Wallace 1995; Wilcox et al. 1981) and that they represent domestic groups that are probably households and extended family households. Suprahousehold groups, called plazuela groups here, are interpreted as descent groups. Larger structural units are only hinted at in most studies.

Wilcox et al. (1981), addressing the structure at Snaketown, noted the significance of an inner ring of mounds (where all of the capped mounds are located) surrounding residential and cemetery areas around a large plaza and Lindeman (2016) builds on that, testing and demonstrating that this inner zone around plazas differs in important respects from portions of villages outside this zone. He also formally defines what he called plaza groups, which we have adopted for this study.

Presented here in a synthesis, one can be forgiven for confusion when looking at the village models proposed in previous studies. For example, comparing Howard (1990:89) to Doyel (1991:250) reveals very different structures and it can be seen that Doyel mistakenly equates Henderson's (1986) village segments with those identified by Howard. Henderson's (1986:23) schematic model uses the term 'communal use area' for what are called plazuelas here. She places a series of village segments (aka plazuela groups here) around a plaza with a ballcourt and surrounding communal area off to the side of the plaza. Our model differs from these models in several important respects. First, there are no large communal areas like the ones that Howard proposed. Second, unlike Doyel, we show courtyard groups within a near-plaza zone of settlement that differs from the plazuela groups that are outside this near-plaza zone. The plazuela groups we show have what we refer to as a plazuela for the communal space within or adjacent to them, which contains a cemetery. Doyel (1991:250) calls this space a 'courtyard or plaza' which are two very different things. Third, we now know that hornos/roasting features are present near plazas and ball courts in addition to being near plazuela groups. Henderson's (1986:23) model is the most similar to our template but differs in not showing the near-plaza zone with courtyards and cemeteries, by showing cemeteries outside what are called "communal use areas' (termed plazuelas here) rather within them, and by not showing plazuela groups labeled as such.

Maps of the villages investigated in the study are provided in Figures A.1 to A.42 grouped at the end of this article. Figures A.1 to A.9, showing previously

Table 1. Villages Included in Study*

Region	Site Name	Site No.1	Mapped / Excavated	Core Date Range	Plaza Identified?	Roasting Facilities near Court/ Plaza?	One or Both of Two Highest Mounds Located by Plaza(s)?	Map Included Here or Reference Where Map Can be Viewed	Comments
Middle Gila	Snaketown	AZ U:13:1	Excavated	Pre-Vahki-Middle Sacaton 2	Yes	Yes	Yes	Figure A1; see also Haury (1976) and Wilcox et al. 1981	One definite plaza is present but it is unknown if there are others. We did not visit this site.
Lower Salt	Northern locus of La Ciudad	AZ T:12:37	Excavated	Snaketown-Sacaton	No	Unknown	Unknown	Figure A2; see also Henderson (1986:Figure 5)	Excavations revealed a series of plazuela groups, each with their own plazuela, cemetery, and mortuary processing facilities (Henderson 1986, 1987). A ballcourt is positioned near several plazuela groups. It is unknown if or where there is a plaza associated with the court.
Lower Salt	La Villa	AZ T:12:148	Excavated, tested	Vahki-Santa Cruz	Yes	Yes	Unknown	See Lindeman (2015, 2016)	Portions of a plaza and near plaza area were excavated and data were available from additional studies indicating a second plaza (Lindeman 2015, 2016).
Buttes District, Gila River	Buttes Dam	AZ U:16:4	Excavated, mapped	Santa Cruz-Sacaton	Yes	Yes	Yes	Figure A3; see also Wasley and Benham (1968)	Ballcourt, plaza, and vicinity were excavated (Wasley and Benham 1968); an additional mound was mapped during this project.
Gila Bend	Enterprise Ranch (south locus only)	AZ T:14:19	Mapped, tested	Gila Butte-Middle Sacaton	Yes	Yes	Yes	Figure A10; see also Wasley and Johnson (1965)	Extensive pothunting in northern locus precluded inclusion here. An additional ballcourt may be present there.
Gila Bend	Hi-Vu Ranch	AZ T:14:16	Mapped	Sacaton	Yes	Yes	Yes	Figure A11	Confident in the general location of the plaza, but not specifics.
Gila Bend	Arlington	AZ T:10:244	Mapped	Gila Butte-Sacaton	Yes	Unknown	Not recorded	Figure A12	The eastern portion of the site that has 3 large mounds and a masonry structure probably post-dates the ballcourt village forming the western part of the site.
Northern Periphery	Dixileta	AZ U:15:113	Mapped	?-Sacaton	Yes	Unknown	Yes	Figure A13	

continued

Table 1. Villages Included in Study*

Region	Site Name	Site No.1	Mapped / Excavated	Core Date Range	Plaza Identified?	Roasting Facilities near Court/ Plaza?	One or Both of Two Highest Mounds Located by Plaza(s)?	Map Included Here or Reference Where Map Can be Viewed	Comments
Lower Verde		AZ U:6:96	Mapped	Sacaton	Yes	Unknown	Yes	Figure A14	North end of the continuous settlement recorded as Azatlan to the south.
Lower Verde	Bartlett Flats	03-12-01-0678 (TNF)	Mapped	Sacaton	Yes	Unknown	Yes	Figure A15	One or more mounds surrounding plaza may have been removed by a campground and road.
Lower Verde	Azatlan	AZ U:6:78, AZ U:6:3	Mapped	Pioneer-Sedentary for southern locus, remainder primarily Sedentary	Yes	Yes (at locus 4, others unknown)	Yes	Figure A16	Two of the mounds in Locus 3 were exceptionally large/high and may represent capped or constructed deposits. A plaza is likely in this locus but was not identifiable on the surface.
Upper Queen Creek	Christenson	AZ U:11:226	Mapped	?-Sacaton-?	Yes	Unknown	Yes	Figure A17	The highest mound located on the northeast side of the plaza is significantly taller than all other mounds at the site. Capped mound?
Upper Queen Creek		AZ U:11:227	Mapped	?-Sacaton-?	Yes	Unknown	Yes	Figure A18	A second plaza may be located south of the ballcourt.
Upper Queen Creek	Buell	AZ U:15:392	Mapped	At least Santa Cruz and Sacaton	No	Unknown	Unknown	Figure A19	The largest mounds at the site are at the north end and in the cluster west and southwest of the court. It is not clear where or how many plazas there are. Most likely one is in the northern mound group and another west-southwest of the court.
Upper Queen Creek	Cottonwood Canyon	AZ U:15:55	Mapped	?-Sacaton-?	Yes	Unknown	Yes	Figure A20	Plaza may be irregular in shape with portions east, southeast, and south of the ballcourt. A small midden or mound within the probable plaza space may relate to pothunting.

continued

Table 1. Villages Included in Study*

Region	Site Name	Site No.1	Mapped / Excavated	Core Date Range	Plaza Identified?	Roasting Facilities near Court/ Plaza?	One or Both of Two Highest Mounds Located by Plaza(s)?	Map Included Here or Reference Where Map Can be Viewed	Comments
Middle Gila	Poston Butte	AZ U:15:52	Mapped	Vahki-Soho	Yes	Yes	Yes	Figure A21	The small possible communal space west-northwest of the ballcourt is probably a plazuela. Mound in center of plaza dates to Classic period post-dating the pre-Classic plaza.
Middle Gila		AZ U:14:54	Mapped	Sacaton	Yes	Yes	Yes	Figure A22	There may be an additional plaza associated with the highest mound.
Middle Gila		GR-311	Mapped	Santa Cruz-Sacaton	Yes	Yes	Yes	Figure A23	An additional plaza may be present in the northern mound group.
Middle Gila	Chee Nee	GR-101, AZ U:14:217	Mapped	Vahki-Civano	Yes	Unknown	Yes	Figure A24	Portions of this village to the south of the mapped portion may have been removed by a ditch, railroad, and road. A separate locus with a court was also mapped but not enough was preserved to assess structure and is not included here.
Middle Gila	Granite Knob	GR-149A, AZ U:14:214A	Mapped	Santa Cruz-Sacaton	Yes	Unknown	Yes	Figure A25	Portions of this village south of the mapped portion have been lost due to Gila River bank erosion and deep erosion cuts extending through village. Most of a large plaza is lost to erosion. Surface grass cover demarcates the plaza.
Middle Gila	Gila Butte	GR-1167, AZ U:13:8	Mapped	Vahki-Sacaton	Yes	Yes	Yes	Figure A26	Note that portions of this site were destroyed by gravel mining at the base of Gila Butte on the west side of the prehistoric site.
Middle Gila	Maricopa Road	GR-1157V, AZ T:13:16 (ASU)	Mapped	Santa Cruz-Sacaton	Yes	Unknown	Yes	Figure A27	A slice of this village was excavated (Ravesloot and Lascaux 1993) where Maricopa Road cuts through just west of the mapped portion.
Middle Gila	Hidden Ruin	GR-1120, AZ T:16:9	Mapped	Vahki-Santa Cruz	Yes	Yes	No	Figure A28	

continued

Table 1. Villages Included in Study*

Region	Site Name	Site No.1	Mapped / Excavated	Core Date Range	Plaza Identified?	Roasting Facilities near Court/ Plaza?	One or Both of Two Highest Mounds Located by Plaza(s)?	Map Included Here or Reference Where Map Can be Viewed	Comments
Middle Gila	Gila Crossing	GR-1112, AZ T:12:84	Mapped, tested	Gila Butte-Civano	Yes	Unknown	Unknown	Figure A29	Site has been mapped and portions tested and excavated (Plumlee et al. 2014; Rodrigues et al. 2018). Site surface significantly impacted limiting some measures.
96 Hills/ Durham	96 Hills	AZ AA:4:41	Mapped	Santa Cruz-Sacaton	Yes	Unknown	Yes	Figure A30	
96 Hills/ Durham	Bogard Wash	AZ AA:4:3	Mapped	Sacaton?	Yes	Unknown	Yes	Figure A31	
96 Hills/ Durham		AZ AA:4:6	Mapped	Sacaton?	Yes	Unknown	Yes	Figure A32	
96 Hills/ Durham	Suffering Wash	AZ AA:8:21	Mapped	Pioneer-Early Classic	Yes	Yes	Yes	Figure A33	
96 Hills/ Durham		AZ AA:8:19	Mapped	?-Sacaton-Early Classic	Yes	Unknown	Unknown	Figure A34	
96 Hills/ Durham		AZ AA:8:23	Mapped	?-Sacaton	Yes	Yes	Yes	Figure A35	
Tucson	Rainbow's End	AZ BB:5:5	Mapped	Rillito-Middle Rincon	Yes	Unknown	Yes	Figure A36	
Tucson	Derrio	AZ AA:8:84	Mapped	?-Rincon	Possible	Unknown	Unknown	Figure A37	The village is located on a relatively narrow ridge. Plaza location is tentatively identified.
Tucson	Romero	AZ BB:9:1	Mapped, tested	Tortolita-Tanque Verde	Yes	Unknown	Yes	Figure A38; see also Elson and Doelle (1987:23)	Mapped and tested (Elson and Doelle 1987; Swartz 1991). Village structure is partly deter-mined by the bounds of the relatively narrow terrace the site is built on.

continued

Table 1. Villages Included in Study*

Region	Site Name	Site No.1	Mapped / Excavated	Core Date Range	Plaza Identified?	Roasting Facilities near Court/ Plaza?	One or Both of Two Highest Mounds Located by Plaza(s)?	Map Included Here or Reference Where Map Can be Viewed	Comments
Tucson	Honey Bee	AZ BB:9:88	Mapped, excavated, tested	Tortolita-Tanque Verde	Yes	Yes	Yes	Figure A4; see also Wallace (2012)	Most of site outside of core was excavated and core remapped (Wallace 2012). Core was tested (Craig 1989).
Tucson	Sleeping Snake	AZ BB:9:104	Mapped, excavated	Rillito-Late Rincon	Yes	Yes	Unknown	Figure A5; see also Ezzo (2007)	Most of village excavated (Ezzo 2007).
Tucson	Los Morteros	AZ AA:12:57	Mapped	Cañada del Oro-Tanque Verde	Yes	Yes	Yes	Figure A40	Portions of village outside of core were excavated (Lange and Deaver 1989; Wallace 1995). Because all of the village outside the core has been plowed and mound identification there is variable, only the core is mapped and shown here.
Tucson	Ironwood Village	AZ AA:12:226	Excavated	Tortolita-Rillito	Yes	Yes	Not applicable	Figure A9; see also Bostwick et al. (2016) and Mitchell et al. (2014)	Most of village excavated. Communal (plaza?) space may continue in area without features to the west-northwest and southwest of the area shown in Figure A.9.
Tucson	Redtail/ Silverbell-Coachline	AZ AA:12:149, AZ AA:12:321	Excavated	Cañada del Oro-Rillito	Yes	Unknown	Not applicable	Figure A6; see also Bernard-Shaw (1989) and Jones (2015)	Excavation in two different portions of the site exposed different residential and communal facilities (Bernard-Shaw 1989; Jones 2015). In one, a plastered plaza and associated cemetery and residential area was exposed. In another, a ring of settlement was found surrounding a communal space or plazuela filled with a very large cemetery. Silverbell Road runs between the two loci, taking out a large portion of the site.
Tucson	Valencia	AZ BB:13:15	Mapped, limited excavation	Snaketown - Late Rincon	Yes	Yes	Yes	Figure 39; see also Elson and Doelle (1987)	Detailed surface mapping and artifact collection identified 2 plazas (Elson and Doelle 1986). Excavations largely limited to an early component (Valencia Vieja - Wallace 2003) and a swath along a road through the later village (Doelle 1985; Vint 2020).

continued

Table 1. Villages Included in Study*

Region	Site Name	Site No.1	Mapped / Excavated	Core Date Range	Plaza Identified?	Roasting Facilities near Court/ Plaza?	One or Both of Two Highest Mounds Located by Plaza(s)?	Map Included Here or Reference Where Map Can be Viewed	Comments
Tucson	Martinez Hill	AZ BB:13:7	Mapped	Tortolita-Middle Rincon	Yes	Unknown	Yes	Map on file, San Xavier District, Tohono O'dham Reservation	Two roads removed some surface evidence but most of the village is very well preserved. A previously reported second ballcourt was determined not to be one.
Outlier	Water World	AZ AA:16:94	Excavated	Rillito	Yes	Yes	Not applicable	Figure A8; see also Czaplicki and Ravesloot (1989)	Excavations identified a plaza with adjacent cemetery, ballcourt, and roasting pits (Czaplicki and Ravesloot 1989)
Outlier	Anamax Ballcourt Site	AZ EE:2:105	Excavated	Cañada del Oro -Early Rincon	Yes	Yes	Not applicable	Figure A7; see also Ferg (1984)	This site is located on a narrow ridge and no mounds were present. Most of site excavated other than the plaza (Ferg 1984). The village is dispersed on this and nearby ridgetops.
San Pedro	KEG	AZ BB:15:3	Mapped, ballcourt excavated	Late Gila Butte or Santa Cruz-Sacaton	Yes	Unknown	Yes	Figure A41	Court excavated by Di Peso (1951).
San Pedro	Redington	AZ BB:11:1	Mapped	Pioneer-Sedentary	Yes	Unknown	Yes	Figure A42; see also Wallace (2014:461)	Because rock clearing is required on the terrace upon which the site is located in order to build features and public spaces, plaza and residential areas are readily visible on the surface. To see the clearing outlines, see Wallace (2014:461).

*Site numbers beginning with GR are from the Gila River Indian Community; those listed as ASU are from Arizona State University; and those with TNF numbers are from the Tonto National Forest. All other site numbers are from the Arizona State Museum (ASM).

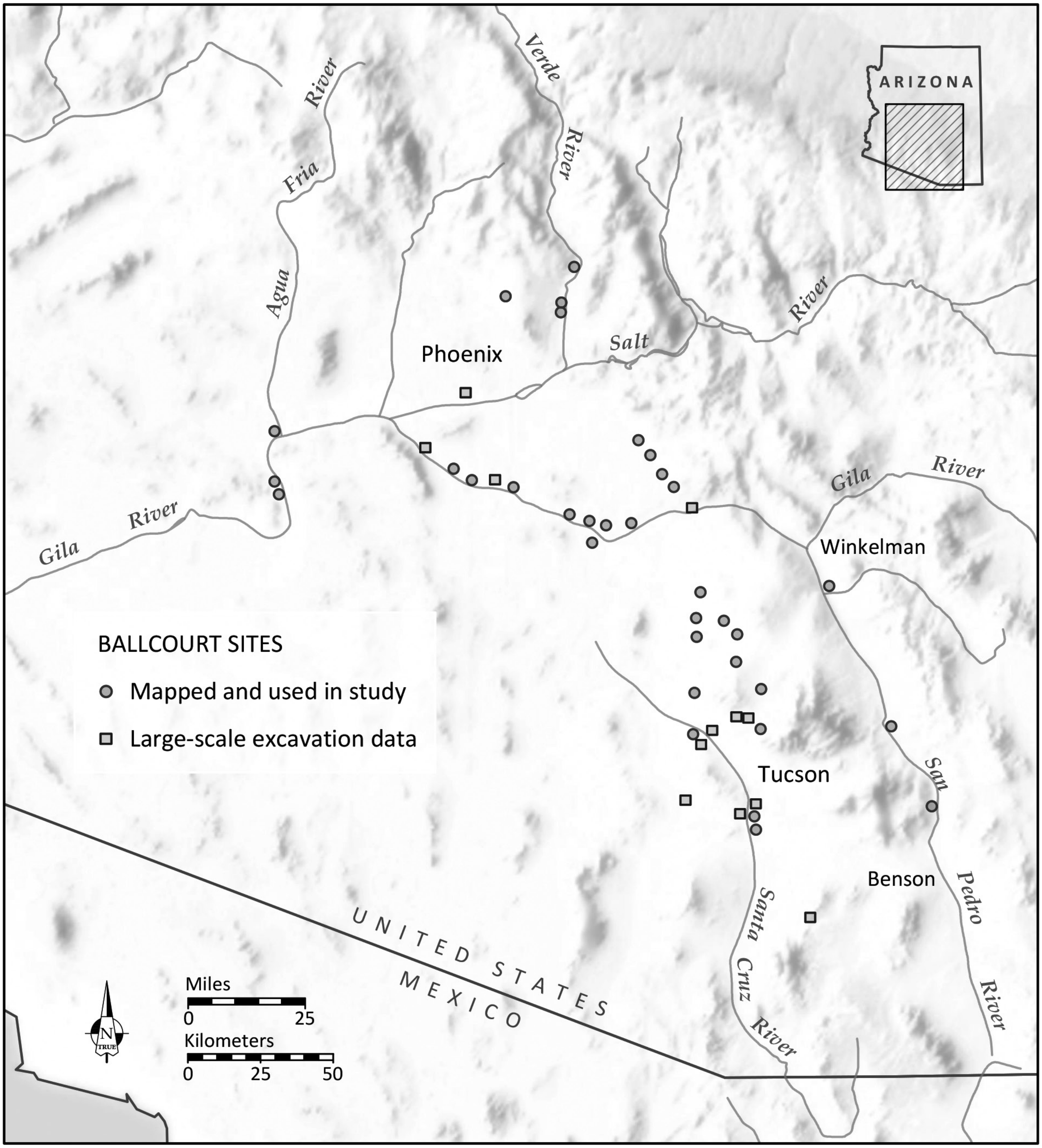

Figure 1. Map of Hohokam village sites included in the study.

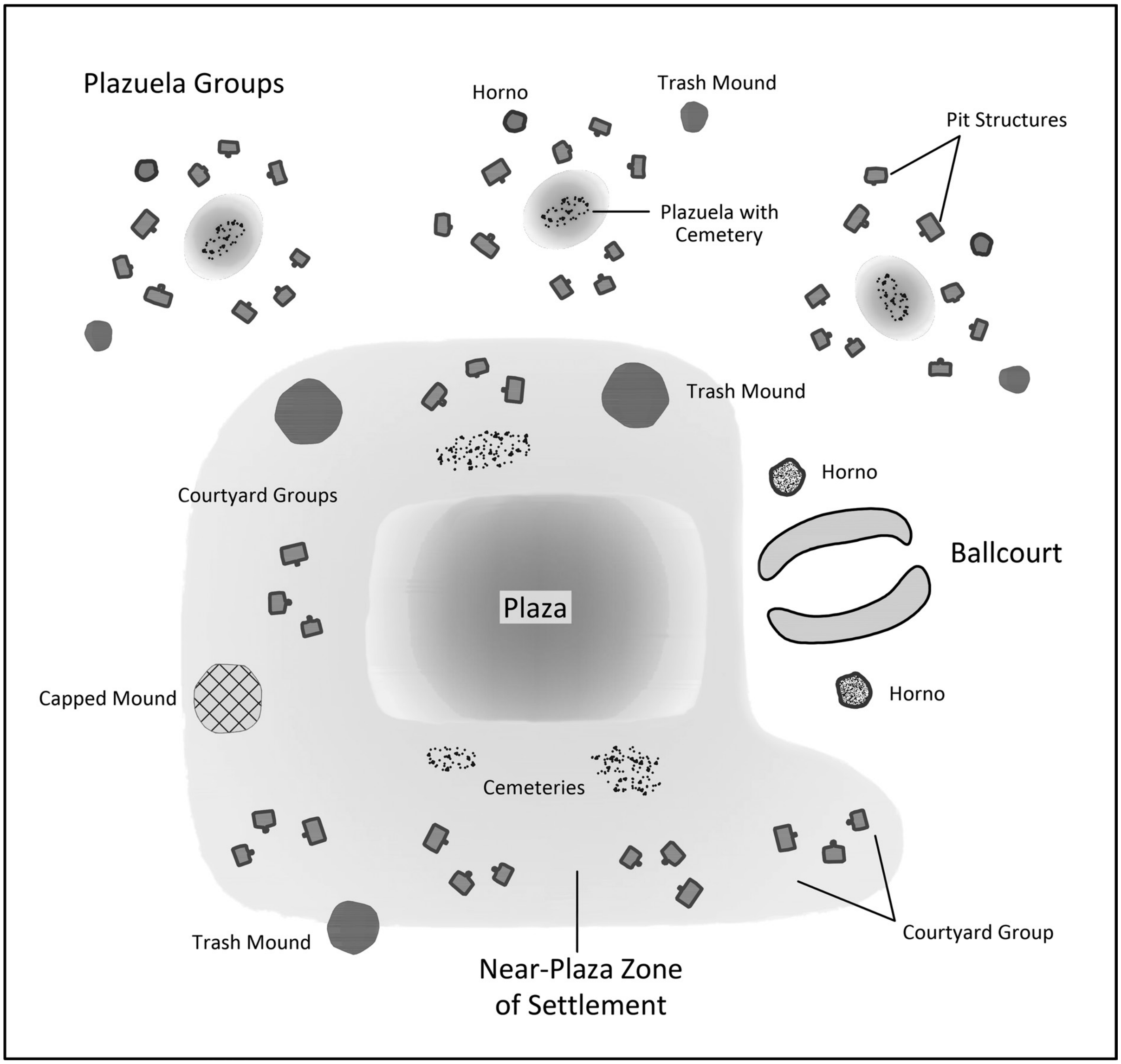

Figure 2. Village structure template identified in this study.

excavated sites important to the investigation, are provided for the reader's convenience. Figures A.10 to A.42 are the sites mapped during this project. Taken together with the settlements that have excavation data, the mapped villages overwhelmingly confirm that plazas are commonly present at Hohokam villages dating to the interval between AD 800 and AD 1050. One village (Buell) that lacks a mapped plaza is still thought to have one, but we lacked the surface clues to be certain of its location. Some settlements have multiple plazas or plaza groups. In some cases this appears to be related to village coalescence. In others, this configuration apparently resulted from internal growth.

Plazas were found to range in maximum diameter from 60 to 121 m, averaging about 87 m with most ranging between 70 and 104 m in diameter (Wallace et al. 2020). Plaza area measures from approximately 1,740 to 14,000 square meters.[3] As excavated plazas are typically bordered by cemeteries and courtyard residential zones and these cannot be identified from surface inspection alone, based on cases where it can be measured, actual plaza open space would typically have been between 12 and 25 m less than these diameter estimates[4] (assuming the cemeteries had surface markers) and the plaza areas would thus be somewhat smaller than the figures listed above. Plaza groups at even the largest villages usually have plazas similar in size to those at small and medium-sized villages (Figure 3; Kruskal-Wallis test finds no significant difference between villages ranked as small, medium and large, p = .1270), suggesting a common need for space at the plaza group level that is

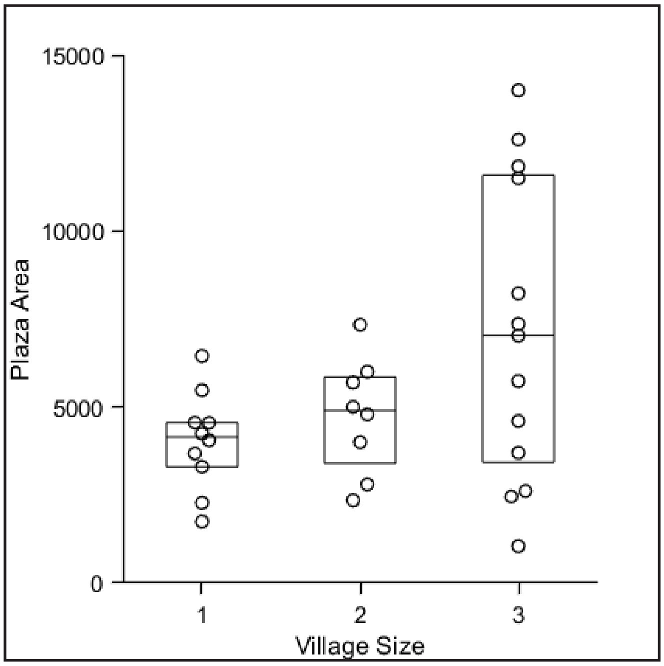

Figure 3. Plot of plaza area (m²) by village size class, showing data points and superimposed box plots. Village size categories are: 1=small, 2=mid-size, 3=large.

independent of overall village size. This is likely related to social constraints on the size of the corporate groups utilizing plazas and points to a likely reason why new plaza groups may form at villages.

A group of four plazas at the largest villages that are over 11,000 m^2 appear to be a class apart from the other plazas (Figure 3). Excluding these cases, the median size of the plazas is 4,550 m^2. For the group of oversized cases, which include plazas at Snaketown, Gila Butte, and AZ U:14:54(ASM) (where two plazas are included in this group), a different function or role is likely. These plazas are found at three of the largest Hohokam villages along the Middle Gila River (Snaketown is the largest). We recorded three plazas at AZ U:14:54(ASM) and there are likely other plazas at Snaketown and Gila Butte.

Contrary to our expectations, we did not find definitive evidence that there is such a thing as a "central" plaza, meaning a preeminent plaza on a village with multiple plazas. If this pattern does exist, the Snaketown plaza would be the best example; however, it would also be necessary to demonstrate there are multiple plazas at the site, which has not been done. One might also suspect that the oversize plazas cited above at Snaketown, Gila Butte, and AZ U:14:54(ASM) might be central plazas, but the presence of two of these large plazas at AZ U:14:54(ASM) makes that less likely. Note that if the interpretation of village structure presented here is shown to be accurate, then if such a central preeminent plaza were present, it would mean that not all plaza groups are equal in social and probably economic and ritual standing.

The proximity of ball courts to plazas was found to relate to the relative construction dates of the plaza group and the court. If the plaza group predates the construction of the court, it is more likely the court will be located outside the ring of habitation around the plaza. If built at the same time, the court is positioned immediately adjacent to the plaza. Courts are slightly more likely to be positioned from northeast to southeast from the plaza.

On excavated villages, it is very apparent that most mounds are associated with courtyard groups or plazuela groups and are, as is most often assumed, refuse deposits. That said, not only is there evidence that some mounds served other or additional functions but that there are data to indicate that the largest mounds are patterned in their location on the villages. For example, it has been posited that villages initially form around plazas with the land immediately adjacent to the plazas being the most desirable location for households to settle and thereby the area used most continuously during the span of occupation (Lindeman 2016). On this basis, one expects the largest refuse deposits to be found surrounding plazas, a contention borne out in the present study with few exceptions. The exceptions observed may be special function mounds such as capped/platform mounds, or they may be associated with plazas not discernible through surface inspection. The largest or second largest mounds are more frequently found on the opposite side of the plaza from ball courts than would be expected by chance, supporting the idea that they may have functioned in a different manner than as just a refuse deposit.

The idea that feasting may have occurred during ceremonies in the plazas or during ballcourt events is supported in this study. All excavated sites with coverage around plazas and courts, as well as 13 of 35 sites that were surface mapped had roasting facilities adjacent to the plaza and/or court(s).

Cemeteries are commonly located around plazas (with early Pioneer period burials found within the plazas) and based on evidence from Henderson (1986) and others, plazuelas typically contain plazuela group cemeteries. This investigation did not specifically focus on the identification of cemeteries; however, existing data, combined with surface and subsurface data, indicate strong patterns that should be considered when conducting CRM investigations.

Overall, there is little evidence of centralized planning at pre-Classic Hohokam villages beyond the basic plaza/court complex (see Smith 2007). Like Mississippian towns, most of the evidence for planning is restricted to the vicinity of plazas; however, unlike that area, there are no axial corridors such as streets, no coordinated buildings aligned with one another, and no buildings that were aligned with extramural walls. The building blocks of Hohokam villages, plazuela groups and courtyard groups, have a certain degree of regularity, but that regularity came from functional and social cues rather than centralized planning. Hohokam villages were built with a basic mental template in mind, but that template was highly flexible and allowed for myriad differences in the local natural and cultural settings.

Snaketown contradicts these generalizations, and this site has a variety of indications for central planning. From its beginnings in the Vahki phase with the construction of an engineered rectangular plaza visible in the topographic map created of the site (Gladwin 1937:8) in a location cosmologically oriented to nearby mountains (Masse and Espenak 2006:279-280; Wallace 2014:478; Wilcox et al. 1981), and continuing through time with the systematic placement of public architecture including mounds and ball courts, Snaketown stands in contrast to the other sites documented here. The presence of Sacaton phase courtyards located south of the plaza with their highly regimented arrangements (Wilcox et al. 1981) indicate a level of coordination and planning beyond that seen with consistency elsewhere. Some of these findings initially led us to search for similar patterns elsewhere, but we did not find them. This leads us to suspect that Snaketown was in fact a preeminent center, at least for the north side of the middle Gila River (see Wilcox and Sternberg 1983:150–153, 198–203).

IMPLICATIONS FOR CULTURAL RESOURCE MANAGEMENT INVESTIGATIONS

It has long been suspected that many, if not most Hohokam villages dating to the span from AD 800 to 1050 had plazas and ball courts. There is a potential tautology here given that we have defined villages as settlements with public architecture and substantial momentary population. For example, if villages are defined as having plazas, then all villages must have plazas. To escape this tautology, it is necessary to look at a very wide range of sites and to determine if some had large momentary populations but had no plazas or ball courts. Surface evidence is inadequate to address this as plazas and ball courts are not always definable on the surface. No sites with large momentary populations that have been thoroughly excavated lack one or the other of these features but there have been very few sites excavated to the extent that one can address the question.

Part of our confidence that all the villages had plazas comes from visiting a large number of sites that were not included in the study due to their lacking visible ballcourts or that lacked sufficient surface features to map. As even small sites we visited, including some with no visible ball courts such as AZ AA:4:40(ASM) and AZ AA:8:18(ASM), had clearly defined plazas, we suspect, given how villages likely form (Wallace and Lindeman 2012), that most, if not all villages have plazas. Ball courts may or may not be present at all villages and this may differ over time. We know that no ball courts have been identified in the Tonto Basin or Middle San Pedro Valley regions (although plazas are present). That said, many ball courts are very difficult to see on the surface and many archaeologists have missed them at various sites where they were later found (no names are given here!). The bottom line for Hohokam archaeologists is that if a site appears to be a village and a plaza is uncovered, one should search for a ballcourt.

Our studies indicate that ball courts are situated immediately adjacent to plazas on very small sites and on many of the sites without long histories of occupation prior to AD 800. For such sites therefore, if a plaza or a ballcourt is discovered there should be an expectation that both may be present. There is also an expectation that roasting facilities will be present nearby both plazas and ball courts. On medium to large sites this will mean one or more hornos as well as smaller roasting features. On small sites, only smaller roasting features may be present.

One mandate of CRM investigations is that human remains should be identified and carefully removed for repatriation to the relevant tribes. Our investigations indicate CRM studies should be certain to conduct 100 percent excavation in the area around plazas, and especially for villages with Pioneer period occupation, the plaza itself should be excavated. In addition, if plazuela groups are present, each must be examined for cemeteries in the plazuelas. For open-sided plazuela groups in the Tucson area, there is an expectation that cemeteries will be present to the east (and sometimes amongst) the housing areas.

On many Hohokam villages encountered in CRM investigations, surface indications of site structure are often lacking due to modern or historic disturbances. For planners and archaeologists tasked with mitigating all or a portion of these settlements, the patterning identified in this investigation can be of assistance in guiding excavations and maximizing returns on data recovery, as well as in minimizing impacts to most sensitive portions of sites.

ENDNOTES

1 Redtail/Silverbell-Coachline is included here and a map is provided in Figure A.6. No ballcourt is known from the site but large portions of the village were not excavated. The gap between the two loci on the map is where the new divided Silverbell Road was constructed.

2 One excavated site not included here with a map is Palo Verde Ruin. The plaza there was not excavated and there are conflicting opinions in print as to its presence and location. Nevertheless, given the extent of excavation the site is important for its information on other aspects of site structure.

3 For surface-mapped sites, we only measured plazas bounded by mounds and ball courts. Measurements were taken from mound edge to mound or ballcourt edge.

4 These figures are from two of the clearest excavated examples, Sleeping Snake and Snaketown, with the former, probably representing the low end of the range given the moderate size of the site, and the latter from Snaketown which is likely to have the upper end of the range. The only other informative case is Buttes Dam, in which the surface and excavated plaza dimensions are the same.

ACKNOWLEDGMENTS

For any multi-year complex project there are many people and organizations who contribute time, effort, ideas, and support. We especially want to acknowledge the logistical and financial support of Sarah Herr at Desert Archaeology, Inc. (DAI) and Bill Doelle at Archaeology Southwest (ASW) (and Bill helped map one 115 degree day at Hidden Ruin). We are grateful to Andy Laurenzi from ASW for his help contacting landowners, providing access to ASW's ballcourt dataset, and his assistance in ways too numerous to mention. Many people aided the authors get to and map on varied sites including Leslie Aragon, Scott Wood, Bruce Hilpert, Jeff Clark, Doug Newton, Roy Fazzi, and John Dawley. Mike Brack and Tyler Theriot managed and processed Trimble data and helped in the field. At Gila River Indian Community, we appreciate the help of tribal monitors Steve Hutchinson and Raquel Romero from the Community's Cultural Resource Management Program. Aaron Wright and his group of Gila Bend volunteers mapped the Arlington site and provided assistance in that region. Catherine Gilman of DAI deserves special credit for her tremendous skill at cartography. She produced all of the figures and maps in this paper with the exception of Figure 3, some of which as the pandemic got going and almost always when she was also piled high with other mapping needs at ASW and DAI. We are very thankful for her skill and kind assistance. Ted Oliver created software for field recording.

We did not make it to all sites we wanted to and could not map all we did but we thank Jupiter Martínez at INAH and Jennie Cure at the Arizona Game and Fish Department for their assistance. Jenelle Wallace helped the senior author run some statistics on plazas and generated Figure 3 and offered sound interpretive advice. Various archaeologists provided leads on sites, site maps, ideas for consideration, and opinions on terminology and for this we especially thank Dave Doyel, Jim Heidke, Dave Wilcox, and Mark Hackbarth. We thank Chris North and Scott Courtright at PaleoWest for sharing CAD data to make it easier to produce the map of Ironwood Village included here as Figure A9. Two reviewers, Glen Rice and Mark Chenault, provided excellent helpful comments on the paper, significantly improving it. We thank them for their reviews. Doug Mitchell, editor at JAA, was exceptionally understanding when the senior author ran into serious delays in the production of the first draft of this paper. He always responded quickly to questions and was most helpful and offered great suggestions and comments. Thanks Doug! Any flaws or mistakes can only be attributed to us. Henry would also like to thank his wife Cyndi for her love and support, even though he was often missing out in the field somewhere. And he especially wants to express his gratitude to the anonymous donor at ASW who funded most of this study.

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NOTES ON THE MAPS

Included here are maps of 42 Hohokam pre-Classic ballcourt villages dating, at least in part, to the period between AD 800 and 1050. Each map provides figure numbers and basic information and references. A sample of previously excavated villages with important data to contribute to the study are included as map Figures A1 to A9. Remaining Figures A10 to A42 are sites we surface mapped or in several cases, included from verified earlier mapping efforts.

The goals of this project required mapping of major cultural features with a focus on core areas of the sites where ballcourts and plazas were situated. It is important to recognize that for the sites we mapped, we did not attempt to map every artifact concentration or rock cluster or other features which did not aid in elucidating site structure. We did map all mounds, ballcourts, hornos, plazas, and roasting features in the core areas of the sites. At particularly large and complex sites, such as Azatlan, and the sites along the Middle Gila, we did not map every site locus and all features present between primary loci. We also did not map modern impacts and vandalism unless necessary to help us in our research. As such, the maps are not suitable for cultural resource managers who require these data.

Most maps will be self explanatory with labeling. One exception is for the ballcourts. They are shown with three symbols: 1) with two continuous ovals indicating bowl-shaped courts that have continuous-looking berms encircling the court; 2) with two berms shown having open ends indicating clear open-ended courts; and 3) with a single line indicating that only a depression was visible or, if an excavated court, one that did not have preserved berms that were mapped. Conventions: 'R' stands for roasting pits/thermal features; 'H' represents hornos or mounds of roasting debris that generally represent one or more buried hornos. Plazas are shown for surface-mapped sites as approximations fitted to the spaces where we were able to discern such indicators as low artifact density, vegetation differences, lack of surface features, and encircling rings of features such as mounds, middens, and ballcourts. Their limits are only approximations in such cases as surface markers are not present for their margins.

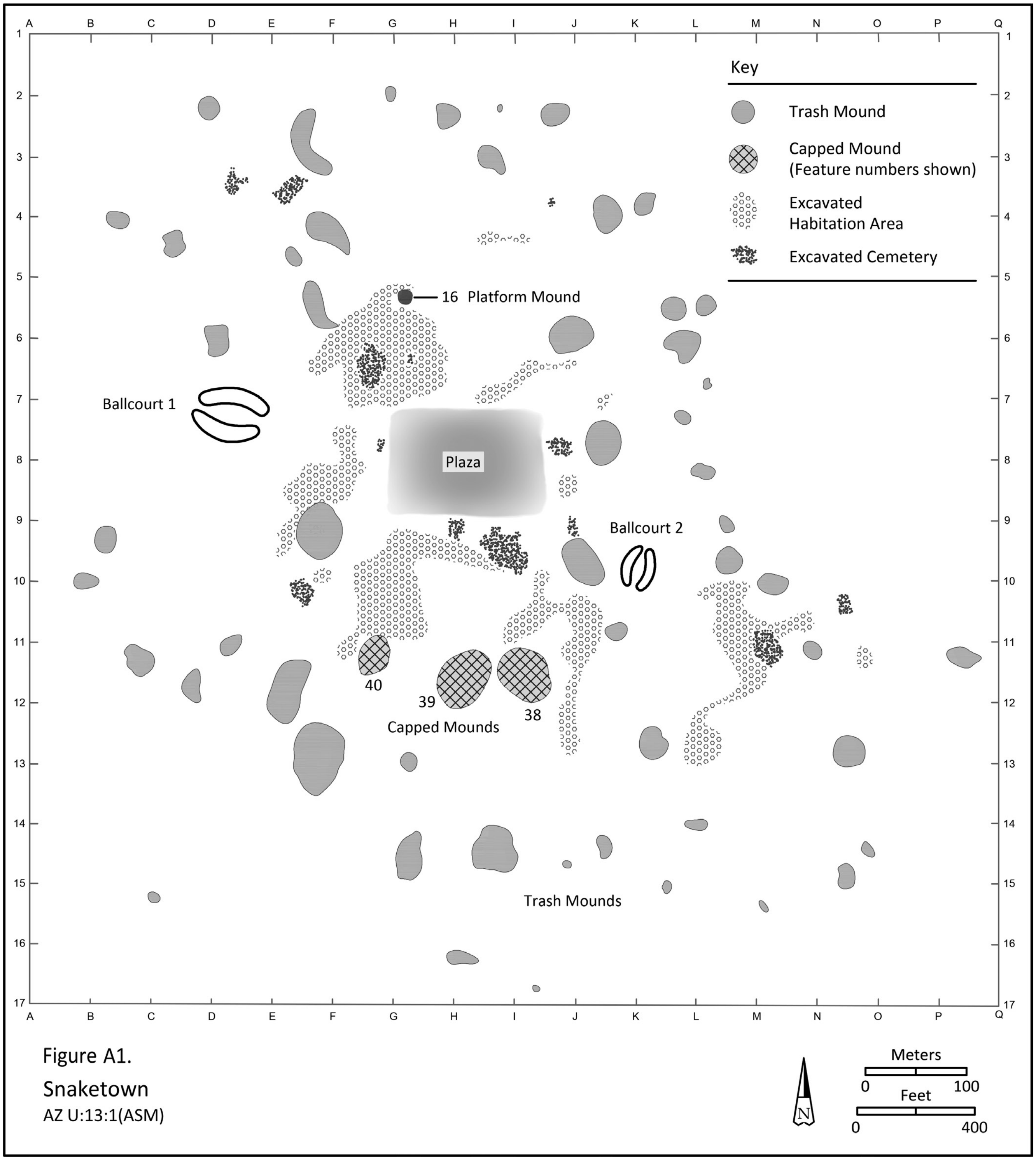
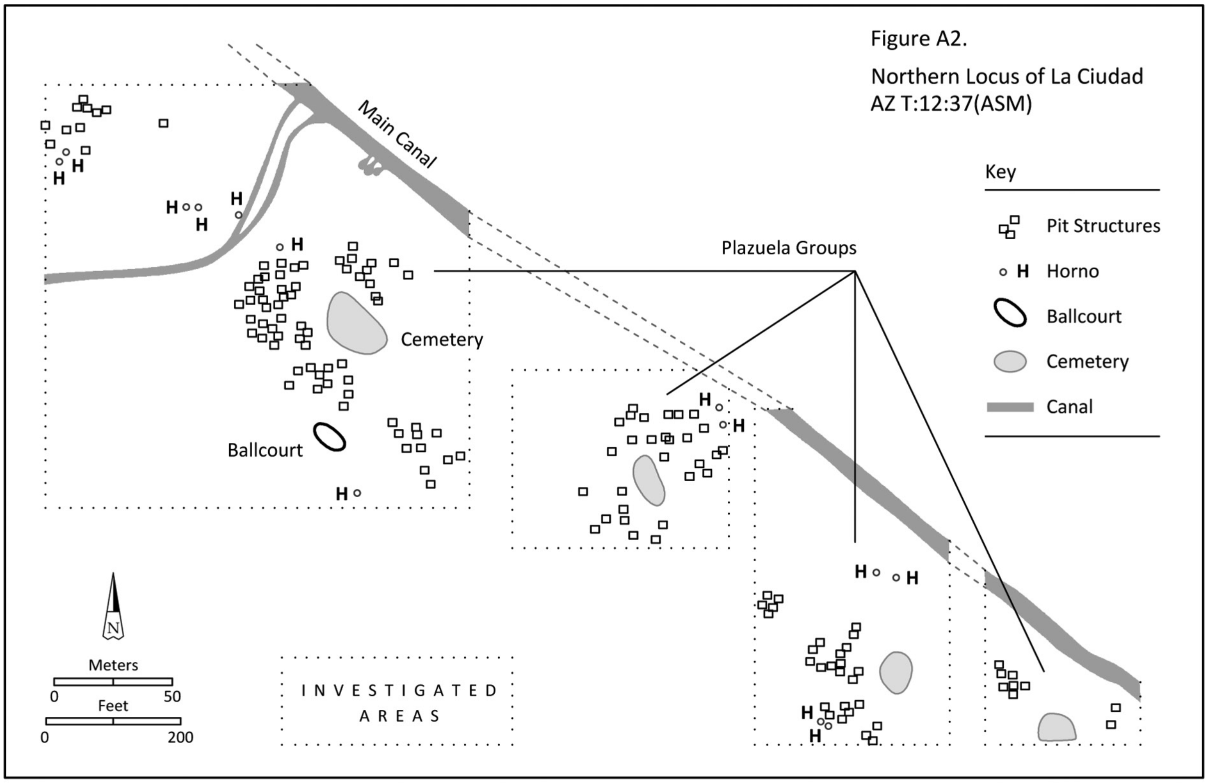
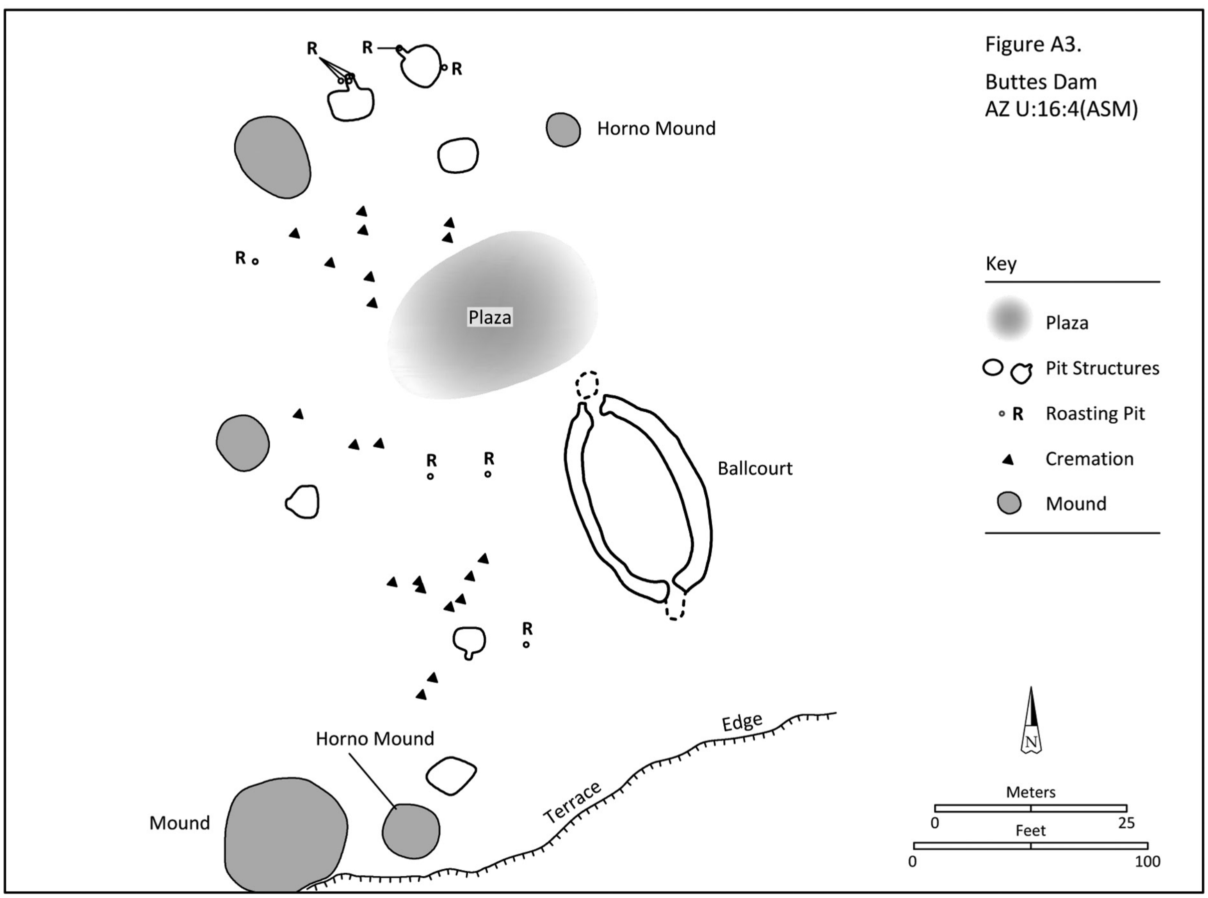


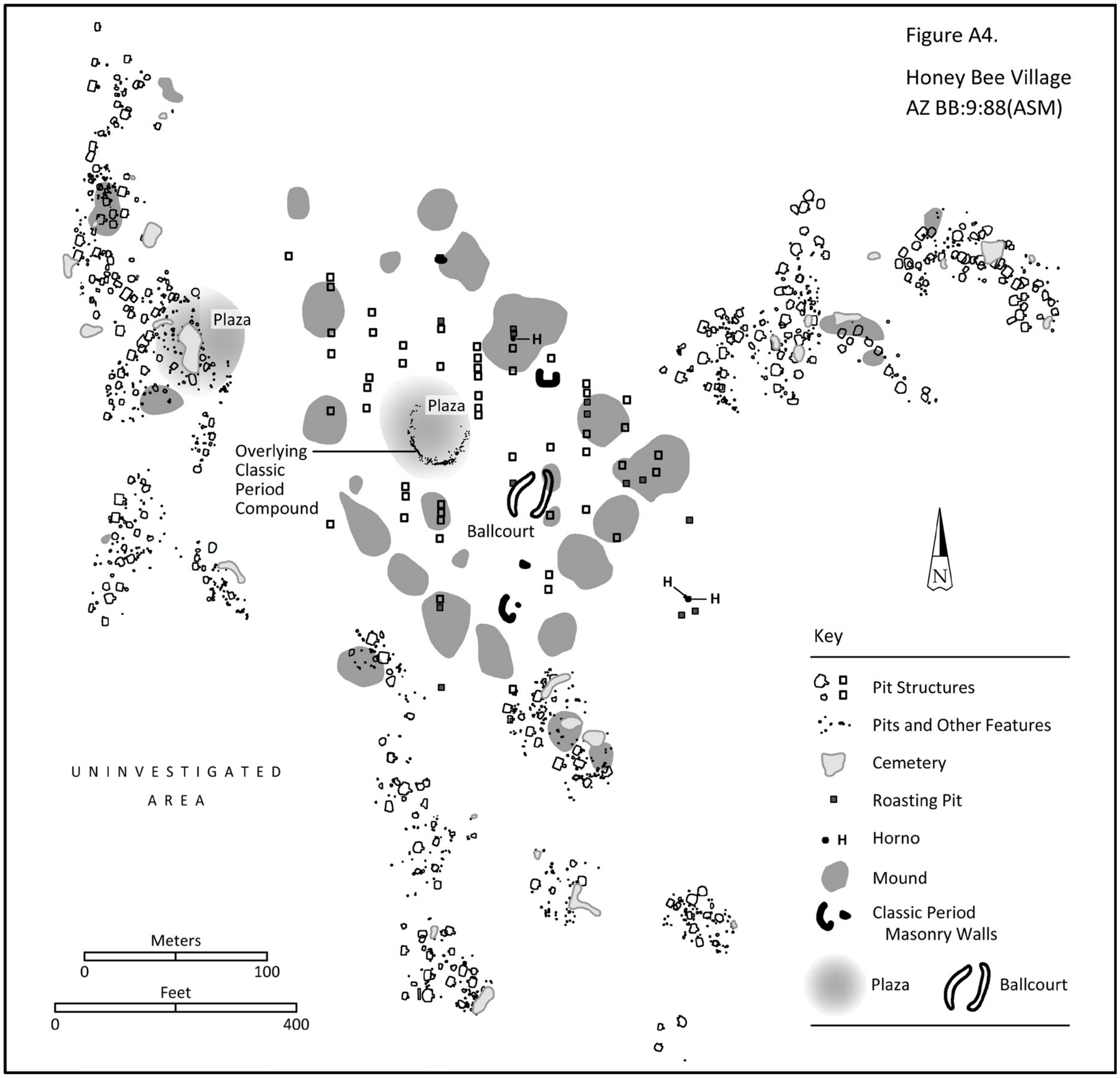
Figure A1.
Snaketown
AZ U:13:1(ASM)

Map Notes: This map was generated from CAD data provided by ASM and mapping data from Wilcox et al. (1981).

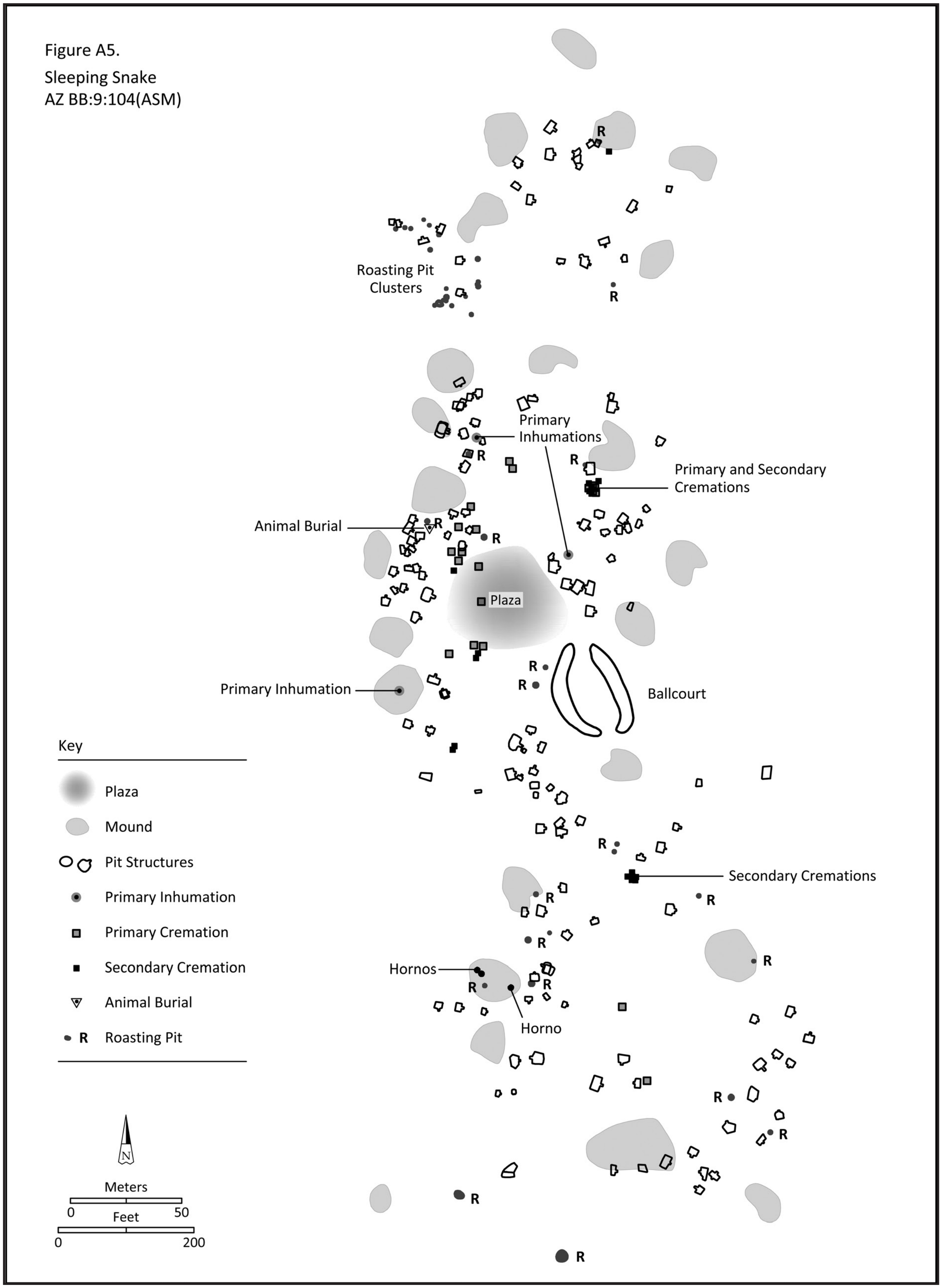




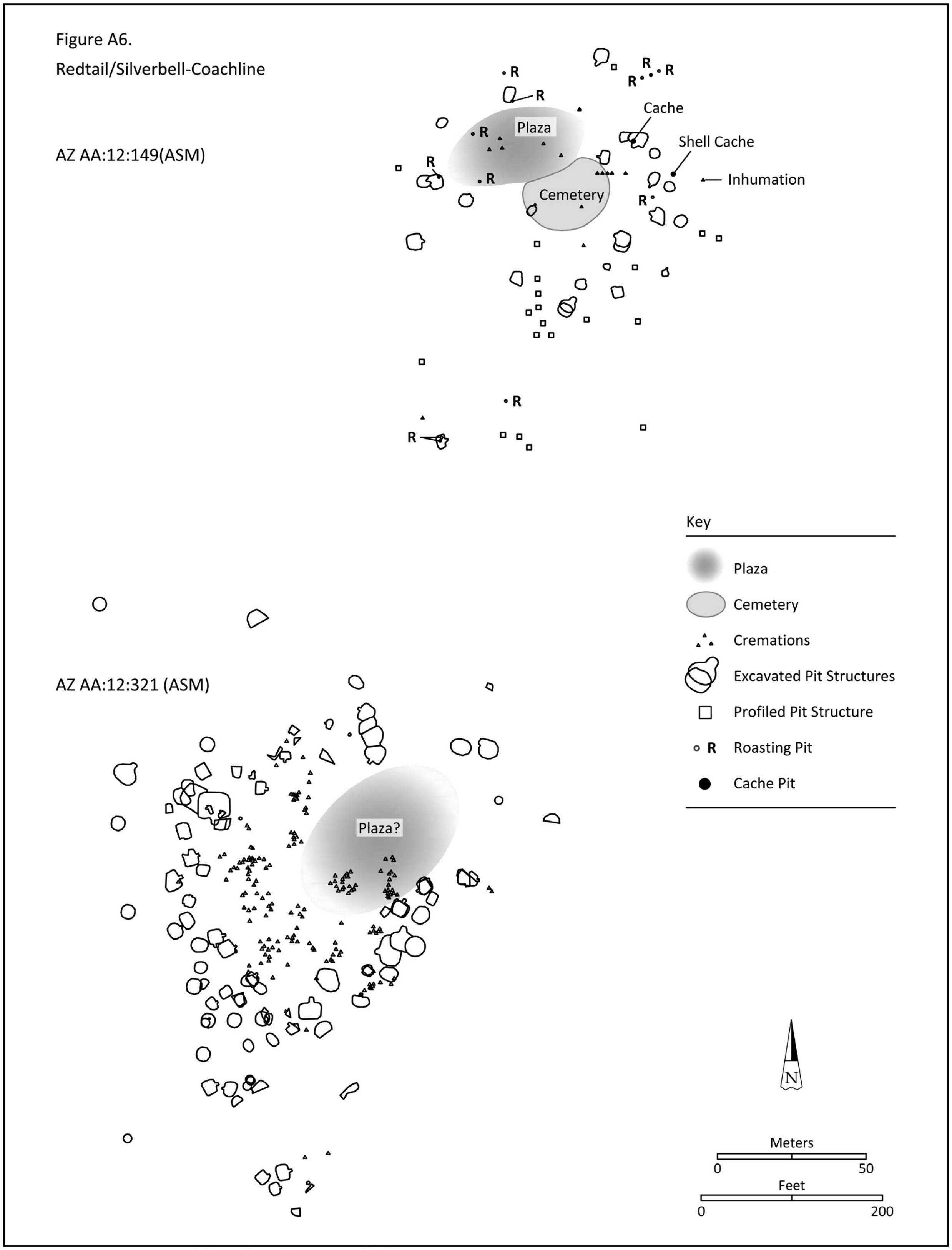
Map Notes: A2) Data for this map was taken from Henderson (1986:Figure 5); A3) Most data from Buttes Dam are derived Wasley and Benham (1968:Figure 2). An additional mound not on their map was mapped in the field as part of this project.



Map Notes: The data for this map originated from Wallace (2012).



Map Notes: CAD data used to help generate this map were provided by Joe Ezzo and Lara Mitchell at SWCA, Inc. and from their report (Ezzo 2007). The map incorporates original mapped surface mounds with SWCA's excavations. Secondary cremations with feature numbers between 200 and 400 are not shown.



Map Notes: This map compiles data from Bernard-Shaw (1989) and Jones (2015). The placement of the portion excavated by Bernard-Shaw is approximated. The central portion of this site between the two components shown was severely impacted by construction and expansion of Silverbell Road.

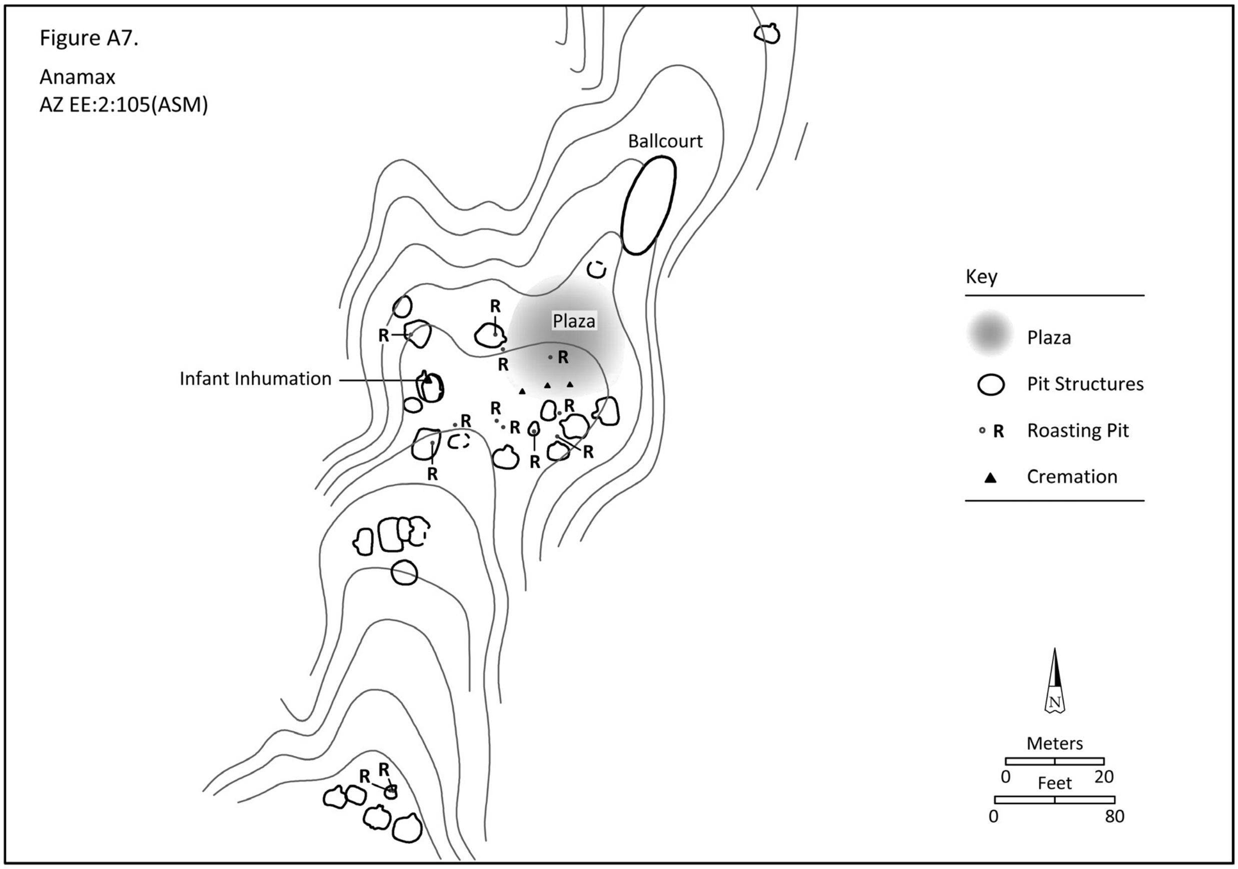


Figure A7.
Anamax
AZ EE:2:105(ASM)

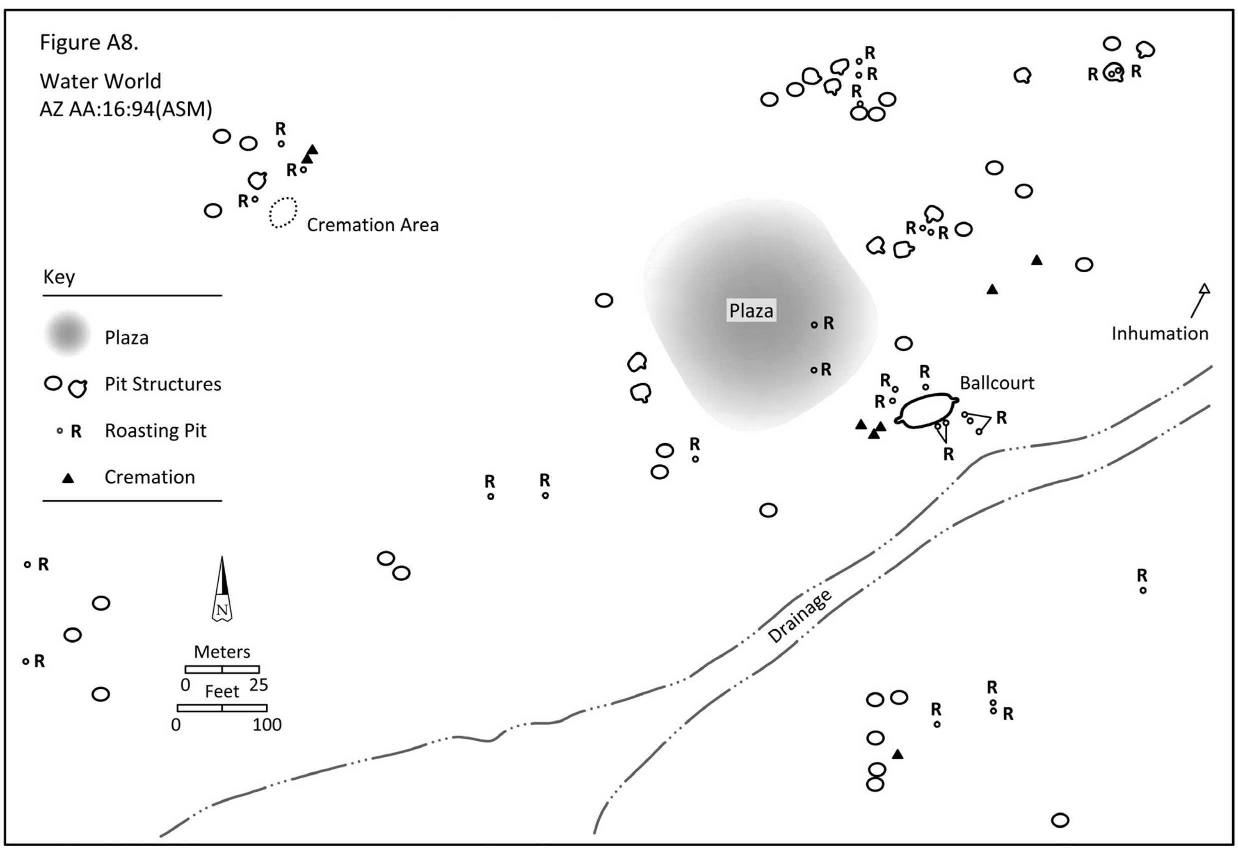
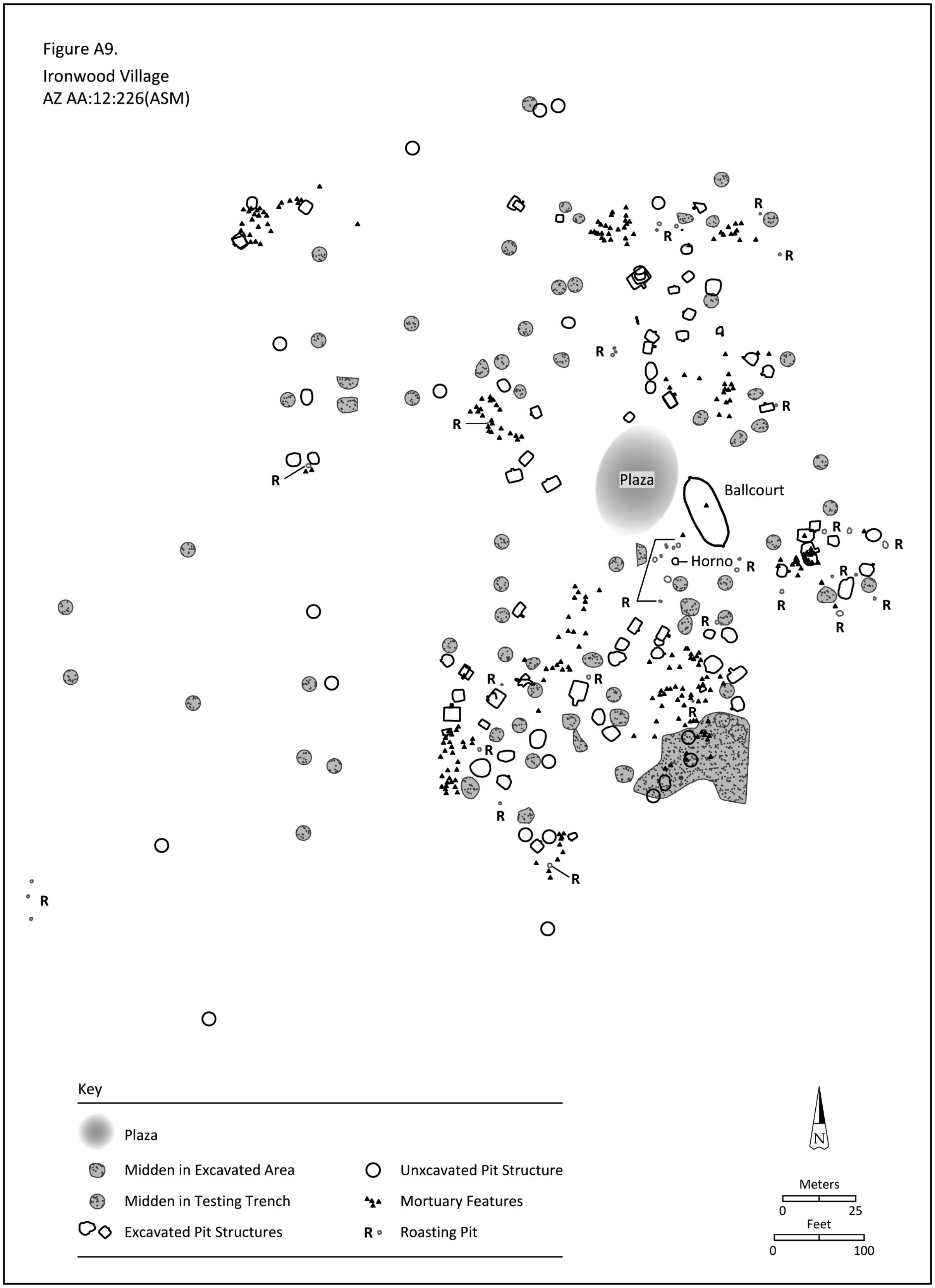


Figure A8.
Water World
AZ AA:16:94(ASM)

Map Notes: A7) Data for Anamax come from Ferg (1984); A8) Data for Water World Data for this map come from Czaplicki and Ravesloot (1989).



Map Notes: Data for this map provided by Scott Courtright and Kathleen Markham at Paleo West Archaeology and from Bostwick et al. (2016) and Mitchell et al. (2014).

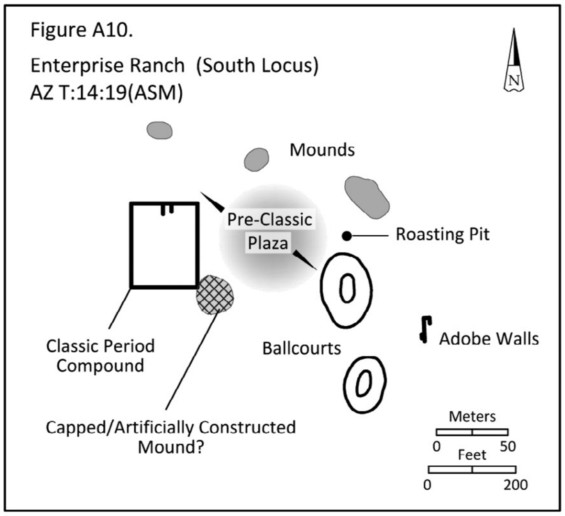


Figure A10.
Enterprise Ranch (South Locus)
AZ T:14:19(ASM)

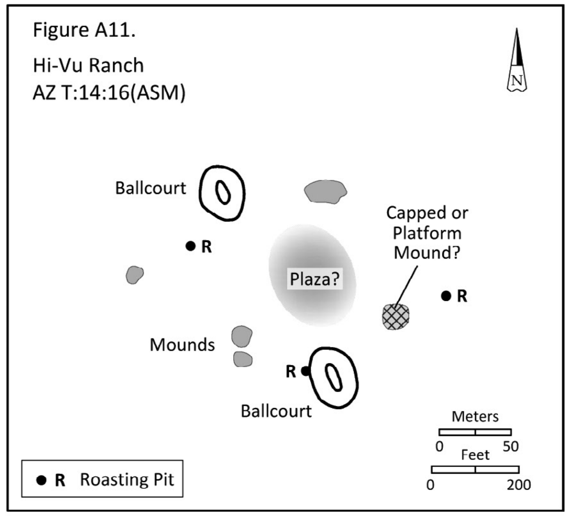


Figure A11.
Hi-Vu Ranch
AZ T:14:16(ASM)

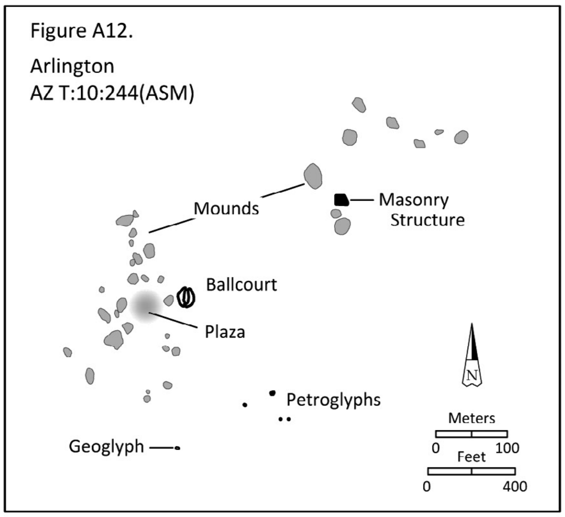


Figure A12.
Arlington
AZ T:10:244(ASM)

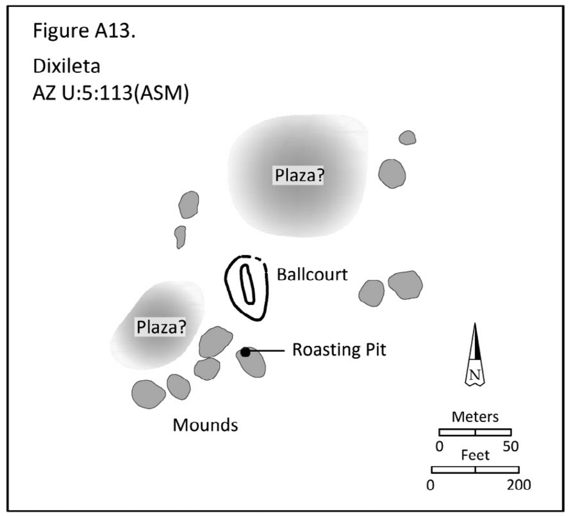


Figure A13.
Dixileta
AZ U:5:113(ASM)

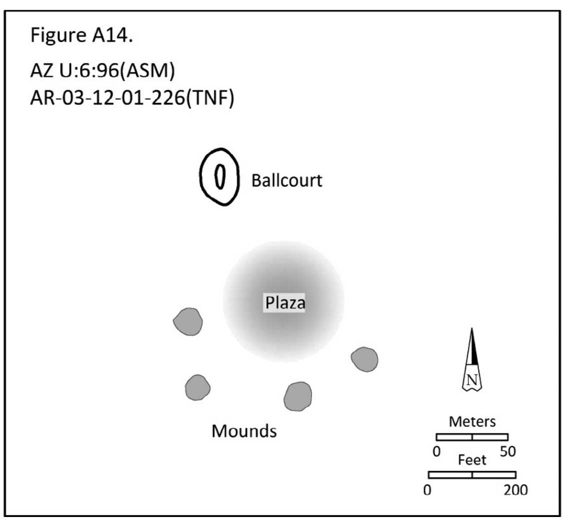


Figure A14.
AZ U:6:96(ASM)
AR-03-12-01-226(TNF)

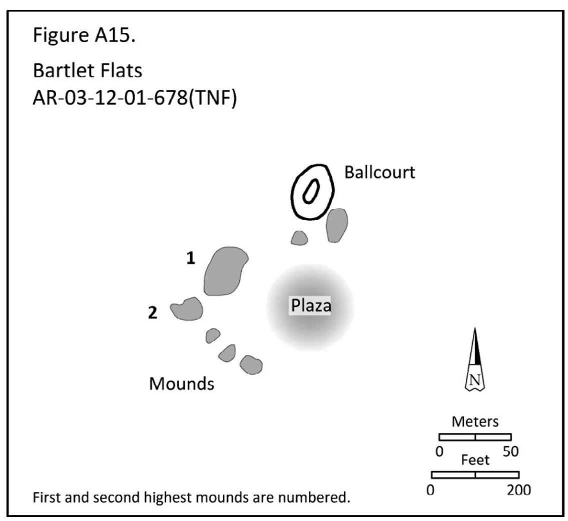
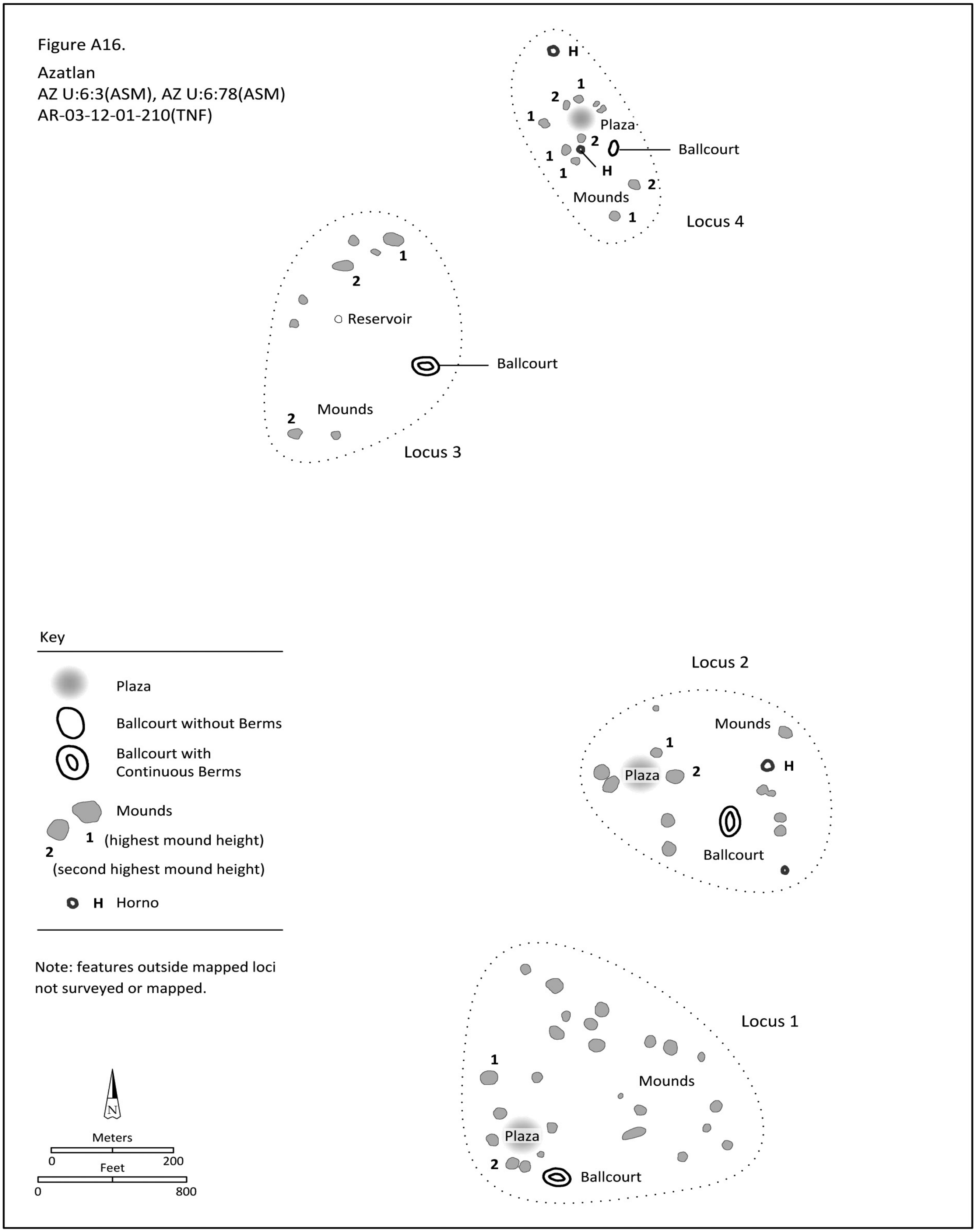


Figure A15.
Bartlet Flats
AR-03-12-01-678(TNF)

Map Notes: A10) The plaza for Enterprise Ranch is shown on this map as potentially shifting in location over time. The northern ballcourt appears to have replaced an older one to the south and in the process, the plaza may have shifted from southeast to northwest. The mound marked as possibly capped was tested by Wasley and Johnson (1965:51) who state it is a trash deposit. We believe it should be reevaluated. A12) An additional portion of Arlington is not shown but includes a probable Classic period compound or rock enclosure. Map provided by Aaron Wright at Archaeology Southwest. A13) The northern open space is most likely a plaza. We are less certain about the one to the southwest of the ballcourt as it is cut by a drainage.



Map Notes: Four loci with concentrations of mounds were mapped for this study. We did not attempt to map all outlying mounds and other features and did not access a portion of site on private land south of the mapped area.

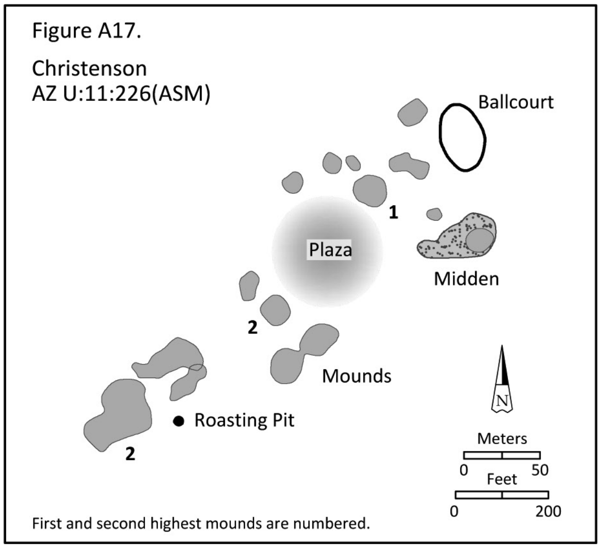


Figure A17.
Christenson
AZ U:11:226(ASM)

First and second highest mounds are numbered.

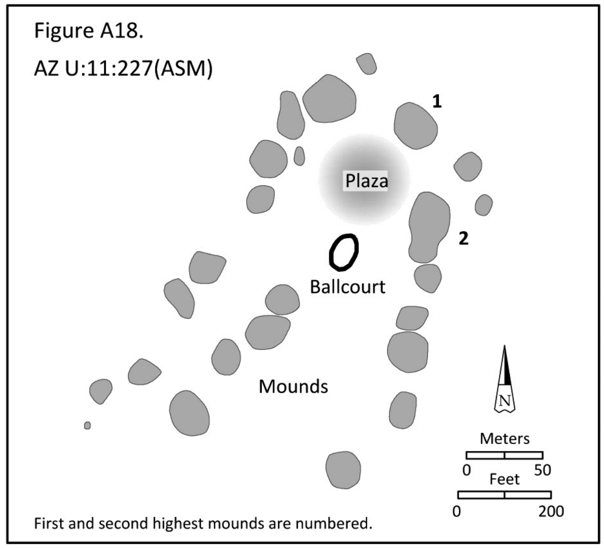


Figure A18.
AZ U:11:227(ASM)

First and second highest mounds are numbered.

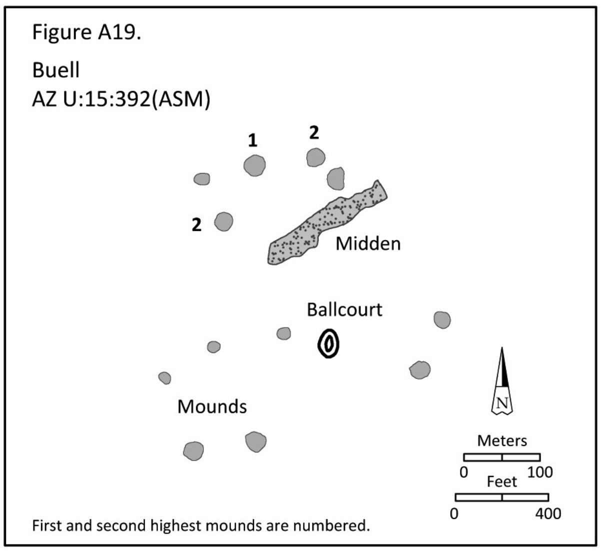


Figure A19.
Buell
AZ U:15:392(ASM)

First and second highest mounds are numbered.

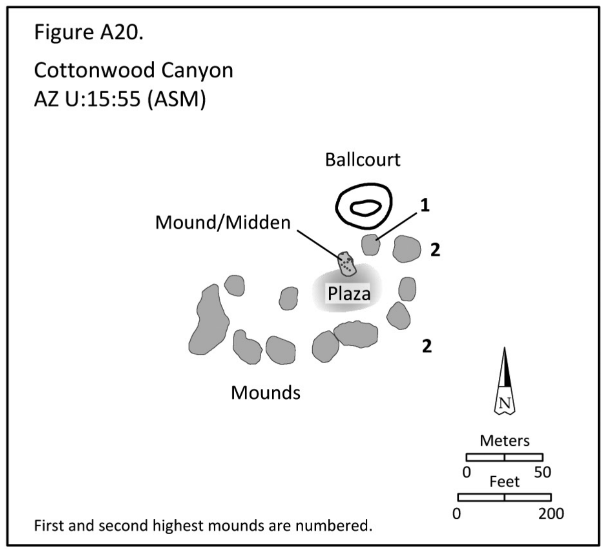


Figure A20.
Cottonwood Canyon
AZ U:15:55 (ASM)

First and second highest mounds are numbered.

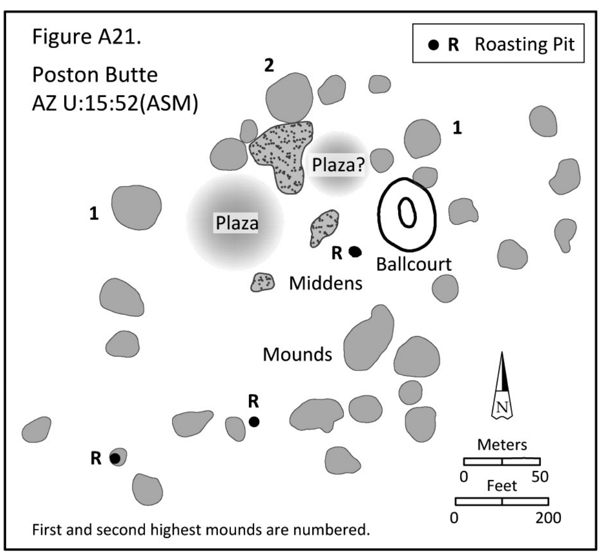


Figure A21.
Poston Butte
AZ U:15:52(ASM)

First and second highest mounds are numbered.

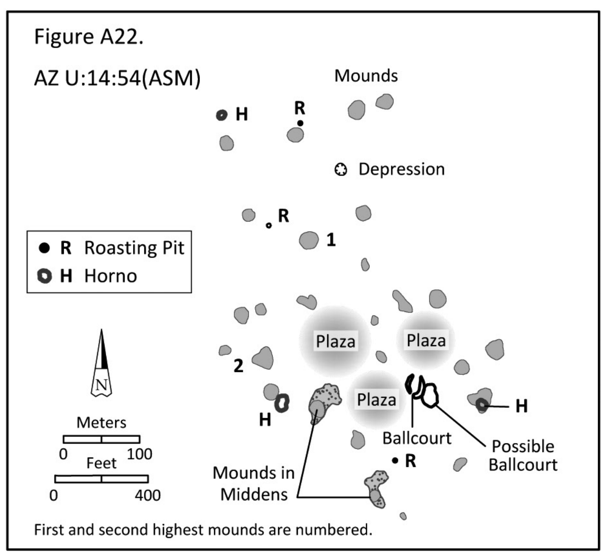
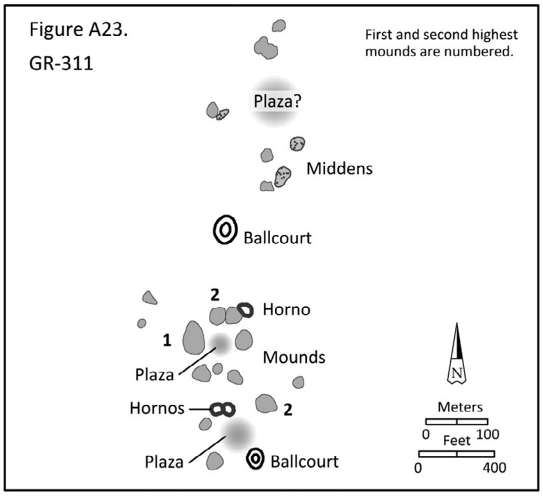
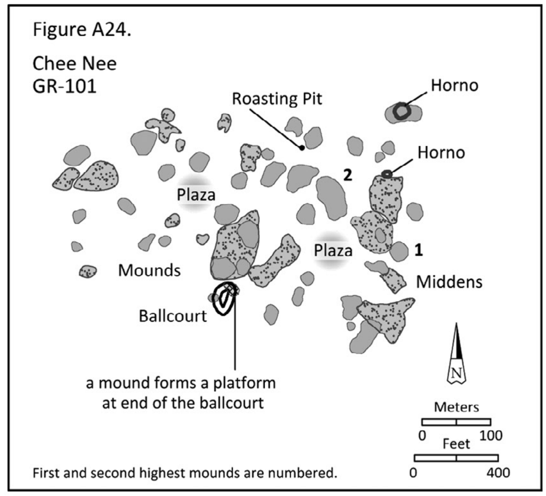


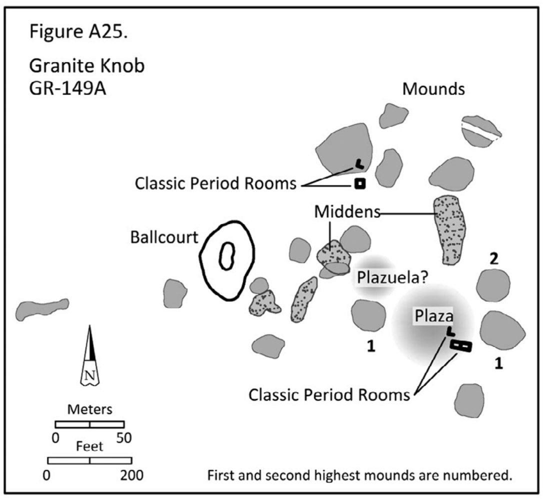
Figure A22.
AZ U:14:54(ASM)

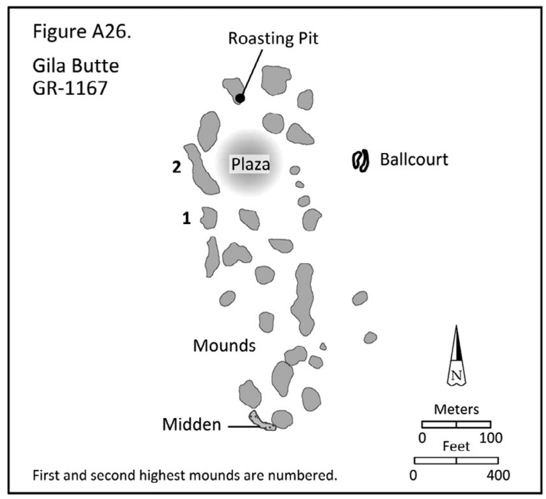
First and second highest mounds are numbered.

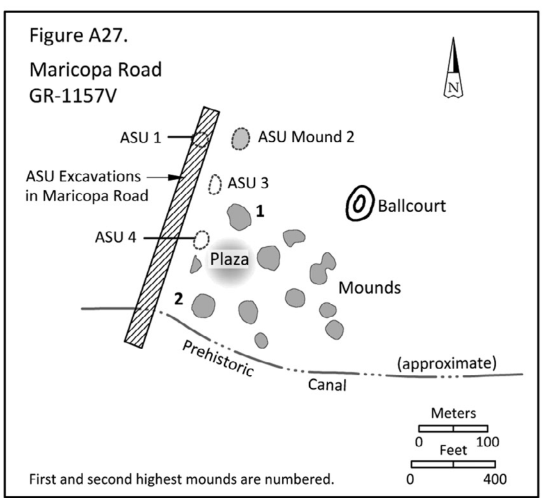
Map Notes: A18) An additional plaza is likely at this site south of the ballcourt but surface data were not sufficient to be certain. A22) This site has a well-defined ballcourt with berms and an adjacent depression. The size and shape of the depression suggest it represents an older court.

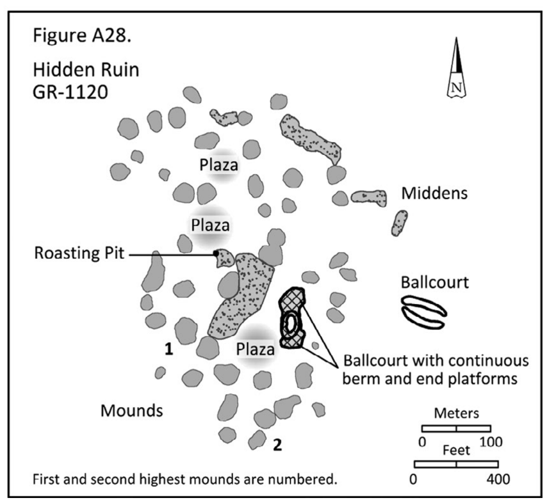












Map Notes: A23) Additional data for this map come from Brodbeck and Neily (1998). A24) The small mound on the west embankment of the ballcourt is shown as overlying the berm. This is not certain and it may predate the court. Additional data for this map come from Gregory and Douglas (1994). A25) Additional data for this map come from Gregory and Douglas (1994). A26) Large gravel pits have removed portions of mounds on the west side of the site and may have removed an unknown number of features there. Additional data for this map come from Neily et al. (2000). A27) The prehistoric canal shown here is taken from data provided by the Gila River Indian Community (Woodson 2010). Additional data for this map come from Ravesloot and Lascaux (1993). A28) Additional data for this map come from Wells and Greenspan (2002).

Figure A29.
Gila Crossing
AZ T:12:84(ASM)

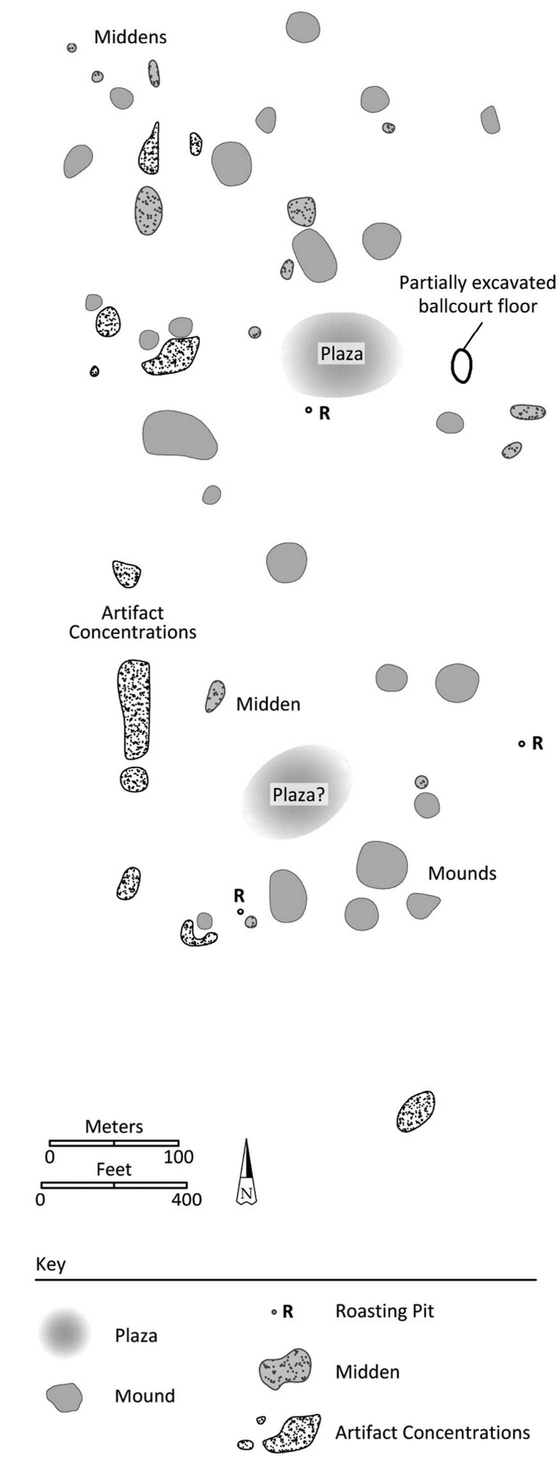


Figure A30.
96 Hills
AZ AA:4:41(ASM)

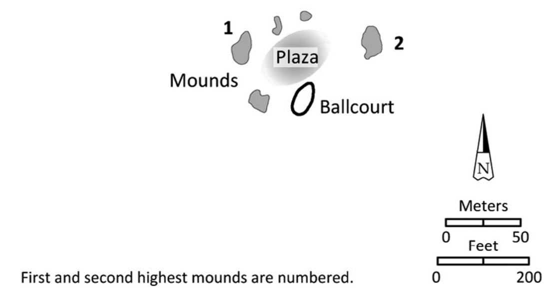


Figure A31.
Bogard Wash
AZ AA:4:3(ASM)

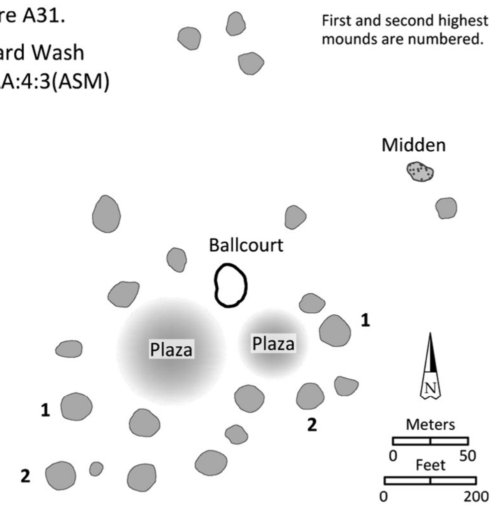
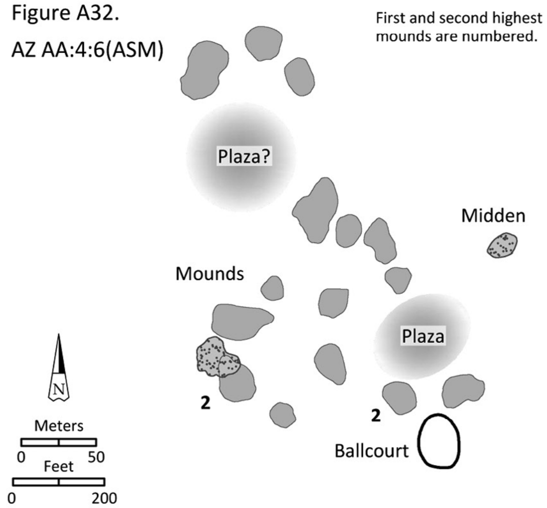


Figure A32.
AZ AA:4:6(ASM)



Map Notes: A29) Additional data for this map come from Plumlee et al. (2014) and Rodrigues et al. (2018). A31) While confident that the two areas shown as plazas on this map were communal space, we are not certain that they represent two plaza groups. It is possible that one or the other might serve a special function.

Figure A33.
Suffering Wash
AZ AA:8:21(ASM)

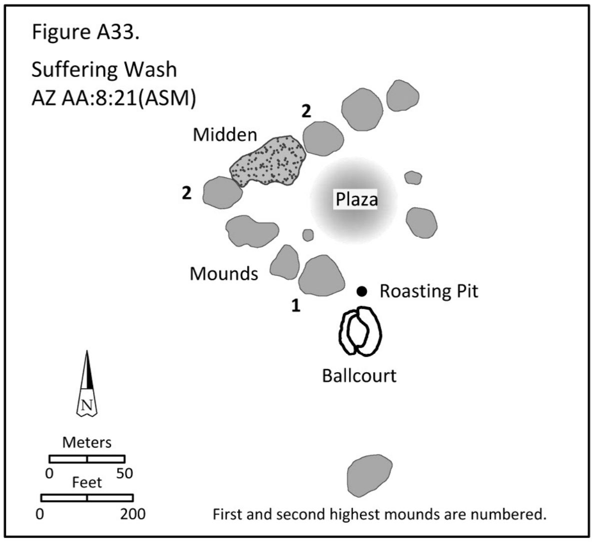


Figure A34.
AZ AA:8:19(ASM)

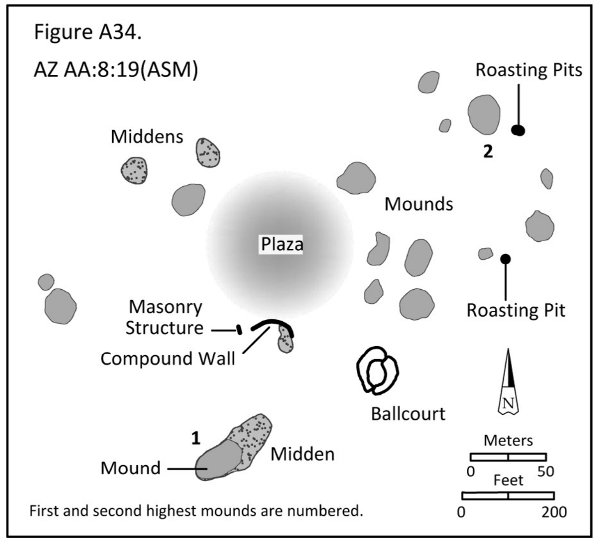


Figure A35.
AZ AA:8:23(ASM)

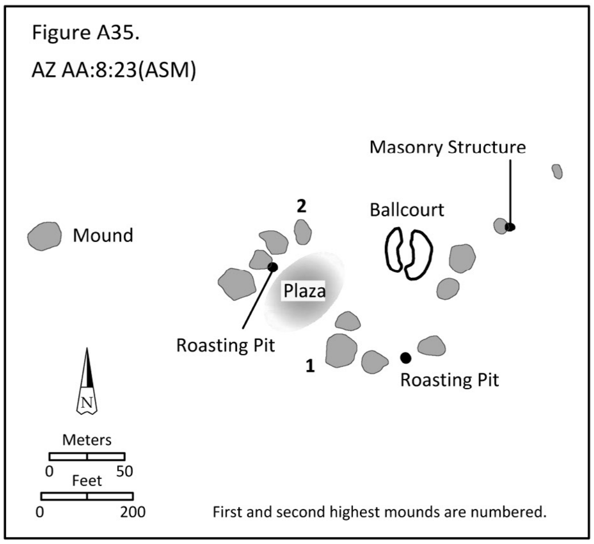


Figure A36.
Rainbow's End
AZ BB:5:5(ASM)

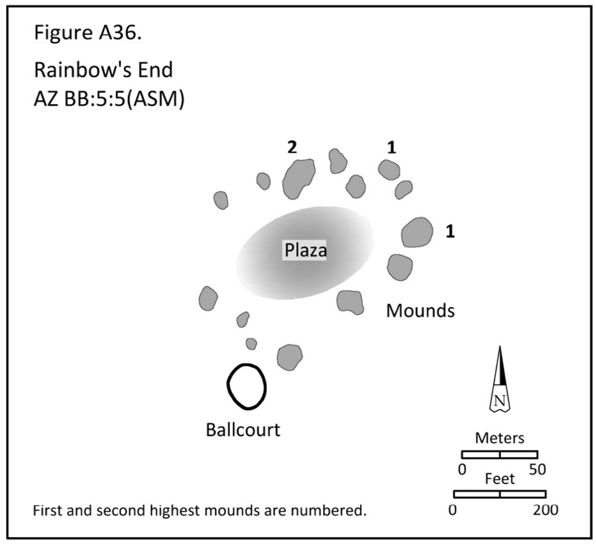


Figure A37.
Derrio
AZ AA:8:84(ASM)

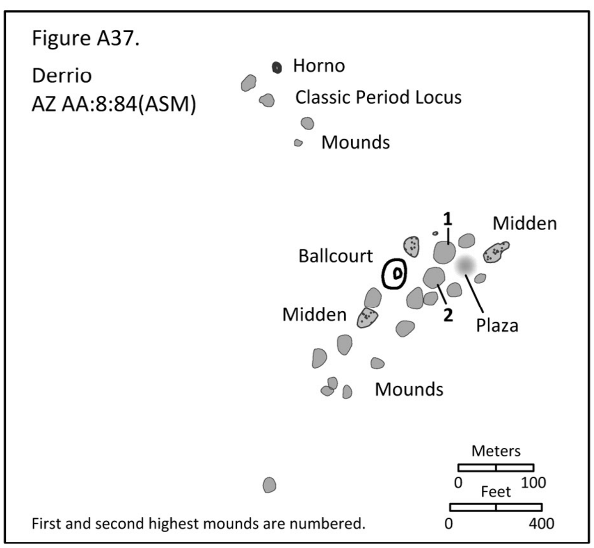
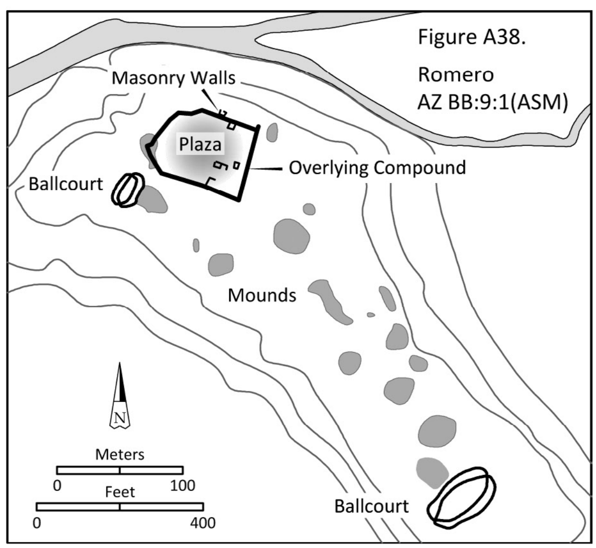
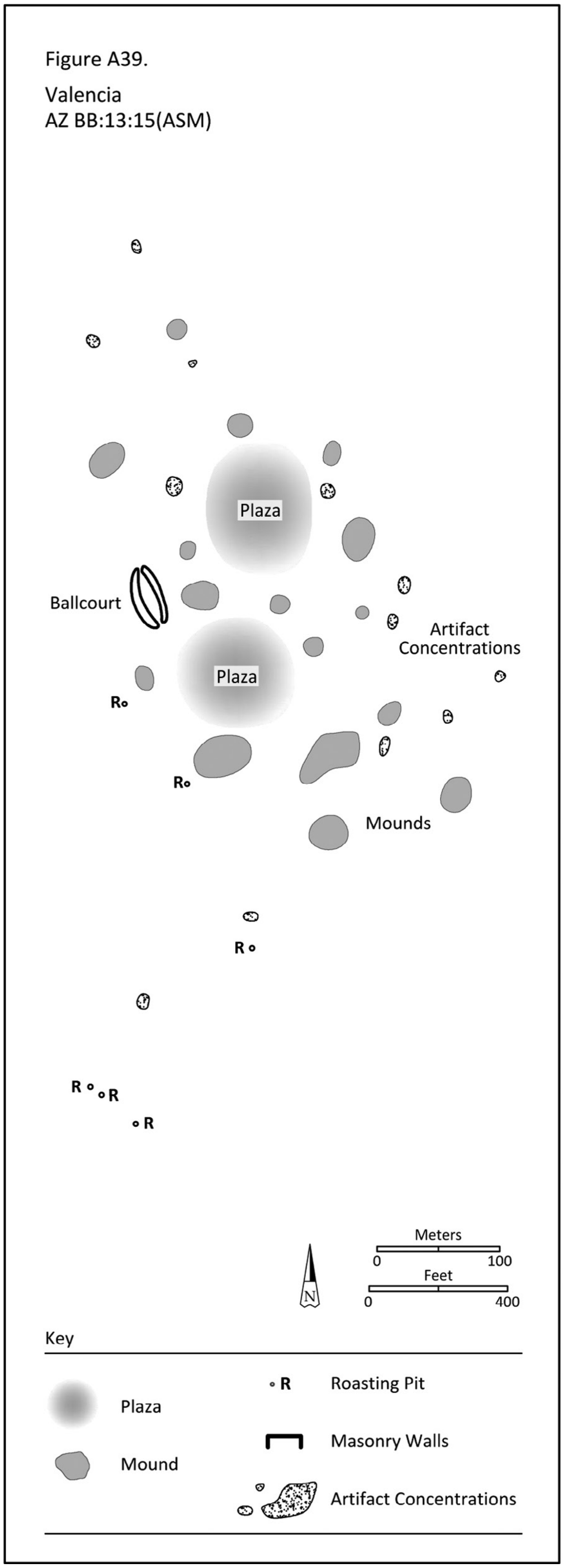
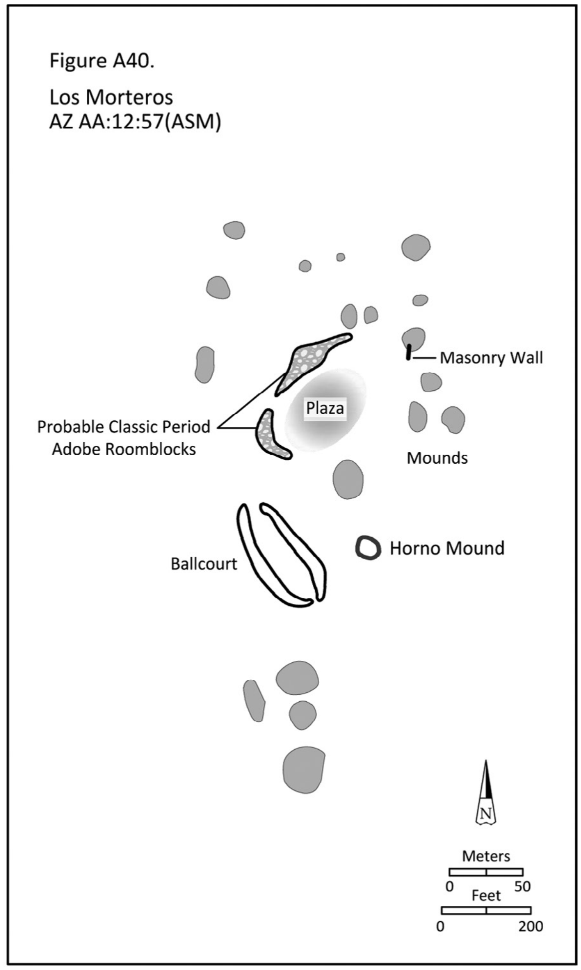


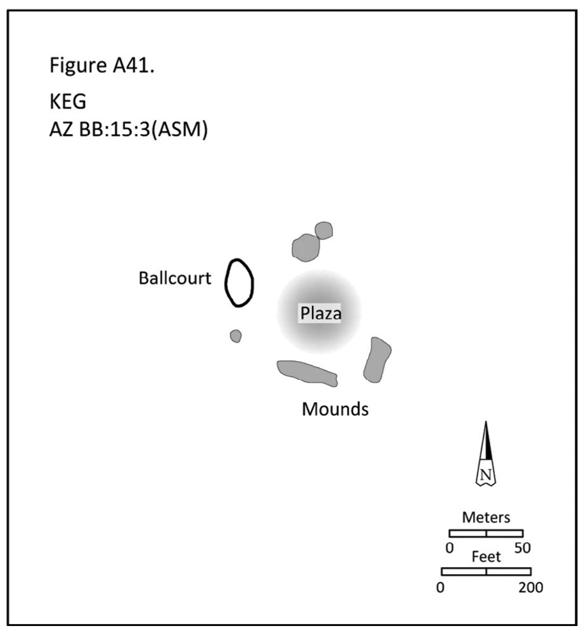
Figure A38.
Romero
AZ BB:9:1(ASM)



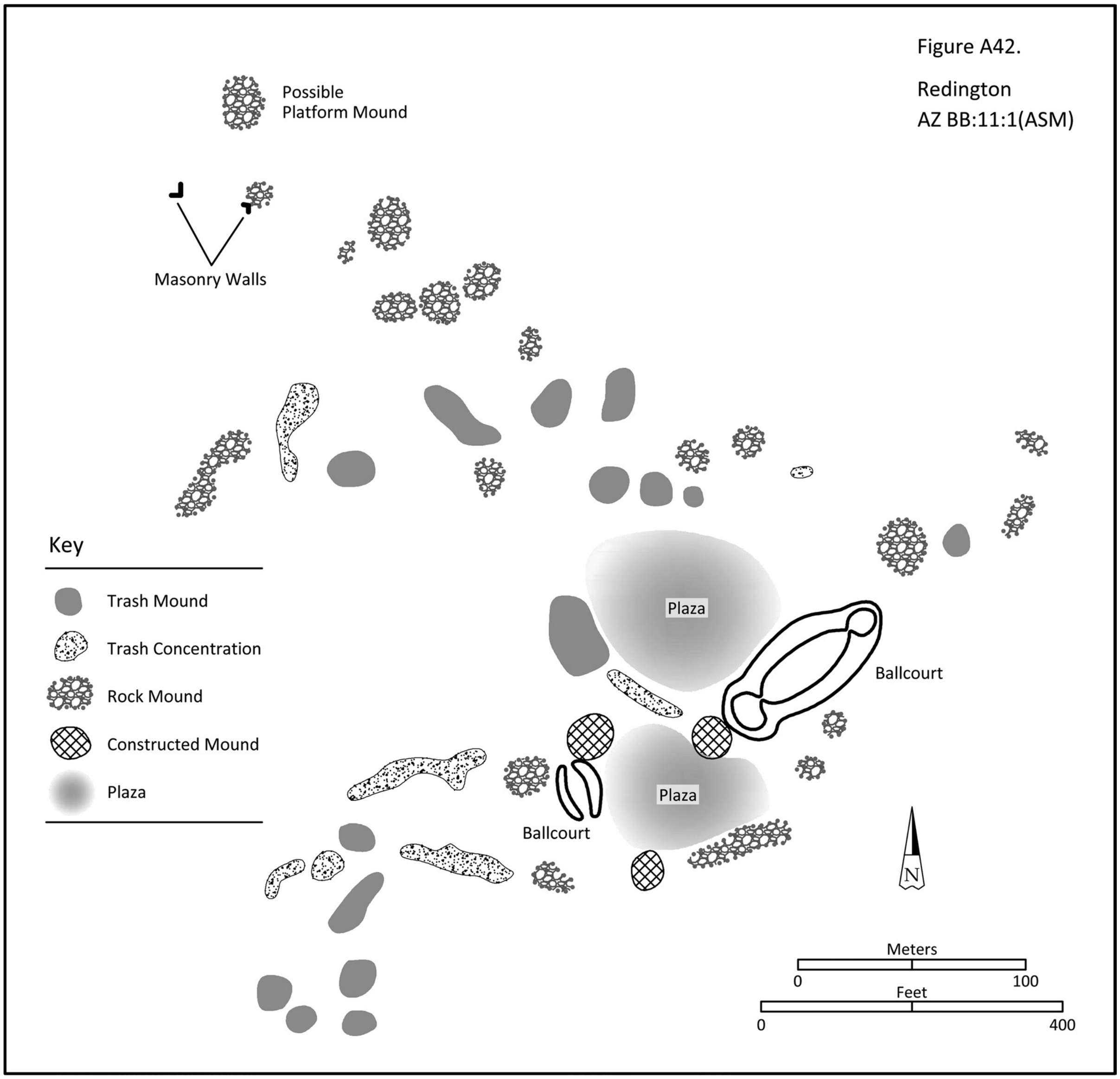
Map Notes: A38) Data to generate this map were derived from Elson and Doelle (1987:Figure 3.2).







Map Notes: A39) Data from Elson and Doelle (1986) were used to generate this map. A40) Data from mapping data provided by Geo-Map, Inc. in 2007 and from our mapping work. A41) Precise placement of the court is only possible within plus or minus several meters due to disturbance from excavation.



Map Notes: This map was derived from the detailed map made by James Holmlund of Geo-Map, Inc.

TESTING THE EFFICACY OF GROUND PENETRATING RADAR ON "UNSUITABLE" SOILS: AN EXAMPLE FROM CEMENTERIO LINDO, A HISTORIC INDIGENT CEMETERY IN PHOENIX

Justin P. Rego

A ground-penetrating radar (GPR) sample survey was conducted at Cementerio Lindo, site AZ T:12:279(ASM), the historic Maricopa County cemetery for indigents located south of downtown Phoenix. The purpose was to test the efficacy of GPR for identifying historic graves within the Phoenix Basin, to identify spatial patterns within the cemetery, and to identify unmarked graves. Results of the survey indicate depth penetration was adequate to resolve many reflections likely representing graves and/or buried memorial markers. However, the raw GPR data required extensive signal processing procedures to clarify potential subsurface reflections. Our results indicate alluvial soils in Phoenix are amenable to GPR surveys using a 400 MHz antenna, although depth penetration was poor. The survey was able to confirm the cemetery's spatial organization and association of memorial markers with subsurface reflections. GPR has proven to be a useful tool in delineating historic graves in Phoenix, and modern methods of post-processing can allow archaeologists to clarify raw data collected in areas exhibiting less than ideal soil conditions.

A ground-penetrating radar (GPR) sample survey was conducted within a judgmentally selected portion of Cementerio Lindo, site AZ T:12:279(ASM), the former Maricopa County cemetery for indigents, currently managed by the City of Phoenix Parks and Recreation Department. Testing was completed with the permission of the City Archaeologist. The purpose was to test the efficacy of GPR to identify historic graves in the alluvial soils of the Phoenix Basin using modern GPR instrumentation. Cementerio Lindo is an approximately rectangular 9.4-acre parcel recorded as a multiple component archaeological site by Montero, et al. in 2008, and located south of downtown Phoenix (Figure 1). It is situated on the distal edge of an alluvial fan that intergrades with the Salt River floodplain. The soils within the Salt River floodplain are traditionally considered unsuitable for GPR survey due to high clay and alkaline salt content, and high electrical conductivity. These variables impose limitations on the depth of penetration and resolution typically achieved by the radar pulse waveform. To our knowledge, there are no published examples of modern GPR survey of archaeological resources on these soils, and the dearth of records regarding the spatial organization of Cementerio Lindo presents an opportunity to provide an updated example of the efficacy of modern GPR instrumentation in Phoenix Basin soils.

Cemetery Structure

Spatial patterning of burials within a cemetery may vary depending on time, place, and religion. Most modern and historic Euroamerican burials in North America are primary interments, with or without coffins or vaults, with the body placed horizontally and typically without intrusions or changes in position since burial. The typical pattern of Euroamerican burials, including graves for members of the Catholic, Protestant, and Judaic faiths, is a 6-ft.-deep grave shaft, oriented east to west. Placement of the head at either the east or west end may be related to whether the deceased was Catholic or Protestant (Heilen and Gray 2010:25). In contrast to Euroamerican burials, nineteenth-century Chinese American burials are very shallow (with the top of the coffin 2 ft below the surface) and can contain various artifacts, including whole ceramic or glass vessels and metal food cans. In California, Chinese burials were found to conform to the principles of Feng-Shui, with the heads of the deceased oriented towards a local knoll, and the feet towards an east–west oriented ravine (Rouse 2000:227–229). Christian burials from the

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Figure 1. Survey area on modern aerial imagery.

Middle Ages through the nineteenth century were often under the floor of a church, or in a graveyard surrounding a church, or adjoining a church building (Reynolds 2009). In the US, graveyards separate from churchyards became more common as Victorian norms changed following the Civil War (Jalland 1996).

Variability in nineteenth century burial patterns was evident at Tucson's historic Alameda-Stone Cemetery, where several sections were reserved for members of different religious faiths, secular organizations, and military units. Heilen and Gray (2010) speculate that the burial of numerous Protestant settlers in the cemetery may have influenced some of Tucson's Catholics to view the public cemetery as sacred space, and thus Catholics may have felt less need to bury their relatives in an already crowded consecrated space near the Catholic Church. Based on information derived from excavations in the Alameda-Stone Cemetery, the death of a young child may have been regarded differently than the death of an adult. Catholic children were not always buried near their adult relatives. For example, consecrated space in the Alameda-Stone Cemetery in Tucson was reserved primarily for adults and older baptized children. Infants and small children had a defined section in the cemetery reserved for them (Heilen and Gray 2010). Alternatively, dense concentrations of child burials could be an indication of other phenomena, such as disease epidemics (Ariès 1975).

Cultural Setting and History of Cementerio Lindo

Arizona Territory was established in 1863 when President Abraham Lincoln signed the Arizona Organic Act, which established Arizona as a separate territory from the New Mexico Territory. The political capital of the Arizona Territory was established in Prescott, Yavapai County, near the military base at Fort Whipple. The town of Prescott and Fort Whipple were near gold mines on Lynx Creek and the Hassayampa River, which were often the target of raids by Native Americans displaced by miners. Maricopa County was separated from Yavapai County in 1870 with a newly created county seat in Phoenix (Luckingham 1989). At the time, Phoenix was a small commercial center organized in 1871 near a farming community of the same name; the farming community began in 1867 with the reopening of prehistoric irrigation canals. The town of Phoenix was platted within a 320-acre parcel and designated the Original Phoenix Townsite (OPT) approximately two miles west of the farming center. In 1870, the population of Phoenix-registered voters was 425, but increased rapidly thereafter.

The earliest written records for the county's original cemetery referred to the parcel as the "County Cemetery" or occasionally as "Potter's Field." From 1870 to 1890, unclaimed bodies in Phoenix were buried here, which was located between Madison and Jackson streets and 5th to 7th Avenues, near the southwest corner of the OPT. The first city cemetery was closed in 1884 and burials were removed from the OPT as late as 1885 (Gomez and Hackbarth 2008). Most of the remains moved from the original city cemetery were reburied in the modern Pioneer and Military Memorial Park. However, some burials in the original city cemetery were not marked and were inadvertently left in place (Hackbarth 2013). After the original city cemetery was abandoned, separate cemeteries then developed for churches, fraternal organizations, and private memorial gardens; however, the county's indigents were relegated to Cementerio Lindo, formally established in 1890 by the Maricopa County Board of Supervisors on what was then the southern edge of the town of Phoenix. As originally platted in 1890, the cemetery was a square 10-acre parcel with a boundary that extended farther south than is currently included in the cemetery boundary. Beginning in 1895, some county documents mention the graveyard as the "Salt River Cemetery" or the "Maricopa County Cemetery." In 1968, the name was changed to Cementerio Lindo (Spanish for "Beautiful Cemetery") after federal funds were used to remove debris, reestablish memorial markers, and beautify the grounds. Use of Cementerio Lindo coincided with a sharp increase in the population of Phoenix and Maricopa County (Table 1).

Archival records indicate the first 11 individuals were interred in the cemetery before December 1894; the last burial within the cemetery occurred in 1952 (Montero et al. 2008:33). On average, between 25 and 75 known individuals were added to the cemetery per year during the nearly six decades that Cementerio Lindo received burials. The number of graves in the cemetery represents approximately 0.03 to 0.06% of the total county population for the years 1900–1950 (Montero et al. 2008:35). However, this number underestimates the total number of burials per year because it includes only the individuals for whom a name and date of death is known and accounts for less than half of the grave sites at the cemetery. In 1930, a land exchange with the Hurley Wholesale Meat Company modified the cemetery boundary by extending the western edge while reducing the cemetery along the southern edge (Gomez and Hackbarth 2008:10). Cemetery equipment and records, including the names of interred individuals, the location of graves, and the dates of death for the deceased were lost in a fire that destroyed the caretaker's building in 1951. The location of the caretaker's building is visible in a 1949 aerial photograph, southeast of an intersection of two access roads within the cemetery (Figure 2).

Table 1. Phoenix and Maricopa County Population While Cementerio Lindo was in use*

Year	Maricopa County	Phoenix
1880	5,080	—
1890	10,986	3,152
1900	20,457	5,544
1910	34,485	11,134
1920	89,576	29,053
1930	150,970	48,118
1940	186,193	65,414
1950	331,770	106,818

*Adapted from Gomez and Hackbarth (2008).

The City of Phoenix acquired the cemetery in March 1961 from Maricopa County through a Quit Claim Deed. As late as April 2, 1964 the condition of the cemetery was described as deteriorated with numerous memorial markers either missing or damaged (Asher 1964). Earlier photographs of the cemetery show a mix of level ground, low mounds, concrete slabs, and vertical memorial markers of wood and stone (Figure 3).

In the mid-1960s, a beautification project upgraded the cemetery (Webb 1999). In the most extensive modification of the cemetery, "The ornamental iron fencing interspacing the rock wall on the 15th Avenue side of the cemetery was repaired and reused in the new wall" (Stokely 1967). Approximately 200 memorial markers were created on-site using sand-blasted concrete during the beautification project to replace decaying markers. The upright memorial markers were placed flush with the ground surface to facilitate mowing of grass that was planted and irrigated with a newly installed underground sprinkler system. The beautification project resulted in a neatly trimmed field of grass and several trees (Figure 4); one large tree along the northern boundary was evident on several aerial photographs as early as 1949 (see Figure 2).

Figure 2. Cementerio Lindo in February/April 1949.

Figure 3. Example of cemetery conditions ca. 1920.

More recent efforts to maintain the cemetery include an Eagle Scout project in 1988 that removed grass from around memorial markers. The Pioneers' Cemetery Association (PCA) has conducted sporadic efforts to counter the ground slumping above graves and removal of dirt that covers some memorial markers. In 1990 and 1991, over 200 descendants of individuals buried in the cemetery attended a community wide Dia de los Muertos celebration; a similar event was held in 1993 but had lower attendance. A second Eagle Scout project in 1994 also completed maintenance in the cemetery to enhance its appearance (Cordova 1994). The underground irrigation system failed ca. 1998 and the surface has reverted to bare earth. Repairs to the fence, landscaping, and irrigation system along 15th Avenue were completed in 2009. At present, the level surface of the cemetery inside the fence is largely devoid of vegetation, although tree stumps and annual weeds are present (see Figure 4). A raised driveway lined with parking curbs forms an L-shaped access road within the cemetery.

The southern 150 ft by 660 ft area (2.27 acres) of the original 1890 cemetery is currently under the frontage road and I-17. The PCA maintains burial records for Cementerio Lindo and has conducted archival and field research to determine the number and location of graves in the cemetery. An early effort to survey and locate the graves in the cemetery suggested there were a maximum of 71 rows of graves (east to west) and projected more than 83 graves in each row (Craig 1986). However, Craig (1986) identified at least one location in the cemetery with graves oriented differently than most of the cemetery, which could represent a cluster of children's graves. The suspected rows of children's graves altered Craig's projected number of burials from the standard 83 graves per row. Thus, the expectation of how many graves are present is a range from a low of 5,900 to as many as 7,100 individual plots (Craig 1986).

Cementerio Lindo was the subject of recent archaeological and archival research projects to establish its history, extent and composition, identify the names and origins of individuals interred in the cemetery, and to locate memorial markers that are preserved and exposed on the modern ground surface (Montero et al. 2008). The archaeological survey of the cemetery identified 632 memorial markers visible on the ground surface (Figure 5), plus two isolated artifact occurrences—a prehistoric sherd scatter and a historic sun-colored amethyst glass fragment. In addition to the surface survey of memorial markers, archival research identified the names of 3,178 individuals known to have been buried in the cemetery (Montero et al. 2008:13). As originally platted, the county cemetery was a square covering 10 acres and linked to the city via an access road, now known as 15th Avenue. An additional 2.19 acres was appended to the west side of the cemetery in a land exchange that was completed sometime before 1930. The land exchange transferred the southern portion of the cemetery to the Hurley Wholesale Meat Company. Thus, the current cemetery is currently an irregular-shaped rectangle encompassing approximately 9.4 acres.

A variety of memorial marker types were used within the cemetery. Written records in the Arizona State Library, Archives and Public Records include the notation that indigent burials from 1894 were associated with a "brick number," presumably a fired brick with an inscribed number that corresponds to the number recorded in the county's death records. Other graves were covered with mounds of dirt, concrete, or

Figure 4. Surface conditions of Cementerio Lindo (2015 at left, 1994 at right).

stone, and some graves were surrounded with metal fences or marked with wood or copper name tags. Seashells and other artifacts were used to mark some graves (Montero et al. 2008:24).

A newspaper article in the PCA archives suggests a 1943 survey of the cemetery referred to internal divisions called section, block, lot, row, and grave number for record keeping purposes (Asher 1964); the survey also indicated there were 1,339 headstones in the cemetery (707 more than currently reported by Montero et al. [2008]). The fire that destroyed the caretaker's building also destroyed the cemetery map that showed this organizational information. The locations of many graves were lost after December 1967 when mounds of dirt marking graves were leveled and upright headstones were placed flush with the ground surface. Subsequent erosion, subsidence, and grass cover has been responsible for obscuring memorial markers and grave locations (Montero et al. 2008).

Oral histories recorded in 2008 provide conflicting data about the composition and organization of the cemetery (Reynolds 2008:66-85). People knowledgeable about the cemetery commented that multiple ethnic groups were interred in the cemetery, but that most interments were from the surrounding Hispanic community. Most people interviewed about the cemetery indicated that graves were added to rows sequentially, although other people commented that members of their family were buried near each other. When asked what parts of the cemetery were the oldest, the respondents were divided in suggesting the earliest graves either were in the west or the southeast portion of the cemetery (Reynolds 2008:67). All the oral traditions indicate that memorial markers were relatively common before the 1960s, but many memorial markers were lost when they were placed flush with the ground and became covered with dirt and grass. Family members of Margarita Medina Valenzuela insist that her memorial marker was placed offset from the grave site when it was placed flush with the ground in 1967 (Reynolds 2008).

The recent archaeological survey of Cementerio Lindo documented the location of 632 memorial markers and two possible survey monuments. The survey mapped the location of markers and reported the associated name, age, and date of death for each legible memorial marker (Montero et al. 2008). Results indicate that two markers (Carter Burgess #1616 and #1618) are out of line and appear to have been moved and a marker for Mary Emmet Coit, died January 27, 1967 (Carter Burgess # 1000), postdates

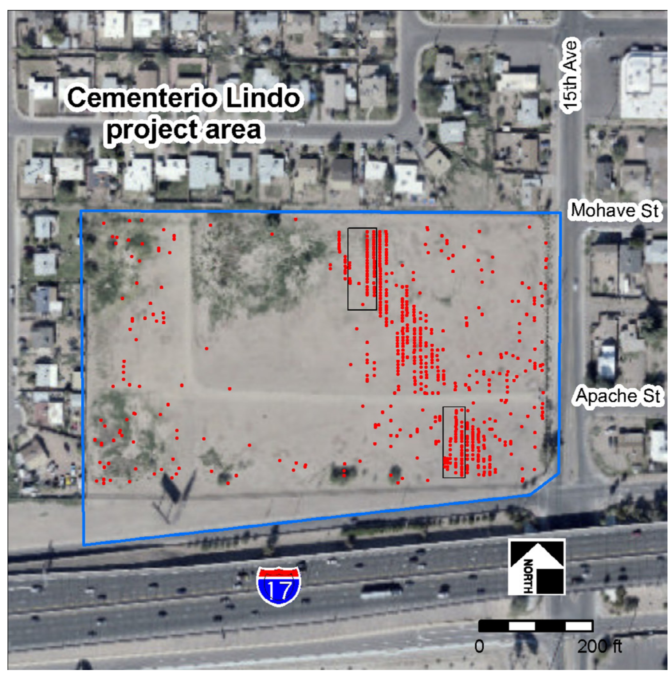

Figure 5. Location of markers as mapped by Montero et al. (2008), with predominately juvenile burial locations outlined.

the closing of the cemetery (Montero et al. 2008). In addition, the western portion of the cemetery has markers that date predominately to the late 1940s (i.e., after the 1930 land exchange). The survey data also suggested at least two locations within the cemetery had only juveniles under the age of 18 (see Figure 5), which may be an effort to maximize the use of space in the cemetery by placing smaller grave sites closer together. The memorial markers reported by Montero et al. (2008) represent between 9 and 11% of the total possible grave sites in the cemetery. Compared to Craig's (1986) tally of potential gravesites, the surface survey data indicate there are a considerable number of unmarked graves in the cemetery.

The archaeological survey report for the cemetery concluded with a recommendation to monitor ground disturbances adjacent to the current cemetery boundary in case early unmarked graves are situated outside of the current cemetery fence (Montero et al. 2008). The most likely location where graves could be outside of the current cemetery fence is along the southern boundary, the area removed in a 1930 land exchange. Oral histories collected in 2008 include the observation that construction trenches for I-17 exposed human remains and that the freeway alignment was shifted to the south to avoid additional graves (Reynolds 2008). Also, widening of 15th Avenue may have expanded the road into the original cemetery.

Ground Penetrating Radar: A Theoretical Introduction

GPR is an active geophysical technique whereby electromagnetic radar pulses are transmitted into the earth using a surface antenna. Originally developed to map glacier depth in Austria (Stern 1929), its modern iteration was developed by NASA to map lunar soil deposition (Simmons et al. 1972). In the years following, the technique was quickly adopted by geophysicists due to its utility in mapping geological features and has now been in use by archaeologists for decades (Gaffney and Gater 2003), flourishing since the early 1990s as computer processing power increased exponentially. GPR has achieved a reputation as being one of the most complex geophysical techniques to perform, due to the large amount of 3-dimensional data that is collected, and the difficulty in processing and interpreting these data (Conyers 2006:131, 2013:12).

Waveforms generated from these radar pulses spread into the ground in a cone and reflect off subsurface materials exhibiting contrasting electromagnetic properties (Conyers 2013:47). The waveform of individual reflections can be digitized into a reflection trace, or a series of waves reflected to one location at the surface. Stacking many adjacent reflection traces can create a two-dimensional vertical profile along a given traverse. These can then be processed to construct 2- and 3-dimensional maps of the subsurface (Conyers 2013:13; Goodman et al. 1995). The two-way travel time, recorded in nanoseconds (ns), can be converted to approximate depth in the ground (Conyers 2013:13-14; Johnson 2006) by estimating the velocity of the radar waveform (Conyers and Lucius 1996: 25) using the shape of the waveform reflection by hyperbola-fitting (Goodman et al. 2006), given an accurate relative dielectric permittivity (RDP) estimation of the media through which the radar waveform is propagating (Stringfield et al. 2008:131). RDP is a dimensionless ratio of a medium's dielectric permittivity to that of a vacuum (Conyers and Lucius 1996:26; Wensink 1993). This property gives a general estimate for how well the radar energy will transmit through a given material to depth; the greater the RDP of a material, the slower the waveform propagates through the material.

GPR waveforms are reflections from subsurface interfaces, including archaeological and natural features, bedding planes, metallic objects, voids, and other modern objects. A reflected wave is generated when a wave's propagating velocity is altered at the interface between materials with differing electrical conductivity and magnetic permeability properties (Conyers 2012:25). Differences in conductivity and permeability is often a function of the amount of water stored in the ground (Conyers 2013:47). Indeed, the differential distribution and retention of water in a soil may be the most significant variable producing radar reflections in sediments with velocity changes of the radar waveform propagation due to the relative proportion of water retained in the buried sediment (Conyers 2012:34). The strength of the radar reflection is proportional to the difference in RDP of the two materials and relies on abrupt interface changes between two materials (Conyers 2013:51). GPR radar energy may not propagate effectively through materials with high RDP values (Reynolds 1998:688). The high RDP of these sediments can cause the radar energy to attenuate, inhibiting propagation into the earth (Conyers 2013:53). Attenuation also is affected by the electrical conductivity of the sediment through which the radar waveform propagates. Moisture content and soluble salts influence the degree of electrical conductivity and can attenuate the radar pulse, causing only shallow penetration to occur (Conyers 2013:53). Depth of penetration is also related to the frequency of the radar antenna, measured in megahertz (MHz). Higher frequency antennas, such as in the frequency of 900–1000 MHz, commonly have a very shallow depth of penetration (typically less than

0.50 m). Lower frequency antennas, such as in the frequency of 400 MHz, typically penetrate 1–4 m in depth. Greater depth of penetration with the lower frequency antenna comes at a cost of decreased vertical resolution. Higher frequency antennas, while having a shallow depth of penetration, have a much higher vertical resolution (Conyers 2013:62). In practice, archeological applications of GPR typically use antennas with frequencies between 250 and 500 MHz (Conyers 2012:27). Most archaeological deposits are shallow, typically within the top two meters of sediment, and mapping of subsurface archaeological deposits requires a high degree of vertical resolution. Generally, for archaeological GPR surveys, 512 samples are recorded per scan, with 120 scans per unit of distance.

Geophysical Surveys on Historic Period Sites in Arizona

Previous published work using GPR in Arizona is scant. The year 1978 marks the first published use of GPR in Arizona, at Tumacácori, where Donald R. Belsher of the National Bureau of Standards used the method to identify flaws in standing adobe structures at Mission San José de Tumacácori, site AZ DD:8:3(ASM) (Crosby 1978:67). Beginning in 1980, the use of GPR to supplement traditional archaeological excavation proliferated in Arizona, mainly pioneered by Bruce Bevan of Geosight, Inc. An initial attempt by Bevan to use GPR in Arizona occurred before construction of I-10 (the Papago Freeway Inner Loop) to sample survey a portion of the right-of-way for the Museum of Northern Arizona (MNA) (Yablon 1981). Bevan located historic structures and prehistoric features with a strong earth contrast, such as those containing ash or charcoal (Bevan 1999). Bevan indicates that historic features were more reliably detected than prehistoric features, including concrete slabs and footings, brick cisterns, pits, trenches and pipes.

Bevan suggests several factors likely inhibited his attempts at locating more subtle archaeological features (Bevan 1999). These factors include surface debris such as metals, which attenuated the radar waveform propagation, as well as the depth of some prehistoric features such as pit houses, which, while exhibiting plastered floors, did not have a great enough RDP contrast to produce a radar waveform reflection. It should be noted that Bevan used a very low frequency antenna (180 MHz) and fairly wide traverses of 10 ft Unlike modern GPR antennas, this antenna was likely unshielded, which would allow noise from all directions to interfere with the radar signal. With this low frequency antenna, only very large archaeological features would be able to be detected and these only very coarsely. This problem would be compounded with 10-ft-wide traverse intervals. Smaller features between these traverses would not been recorded by the GPR.

Again in 1980, Bevan surveyed 2.9 acres of Block 1 and Block 2 of the OPT, site AZ T:12:42(ASM) (incorporated AD 1871) using a 180 MHz antenna at 0.5 m traverse intervals. Here, he was able to successfully map 623 subsurface reflections, many of which likely indicated historic buried foundations (Bevan 1980). Bevan identified features including 1-inch iron pipes; ceramic pipes; boulders; bricks; cement foundations; rubble-concentrations; gravel-filled pits; and stratigraphic layers (Bevan 1980). Stone and concrete foundations were easily identified using GPR because the buildings were cleanly demolished, with little rubble in the fill to mask the foundations (Bevan 2006). Again here, Bevan used a very low frequency 180 MHz antenna, although he reduced his traverse intervals considerably. This may have allowed for smaller radar reflections to be imaged, but given the low frequency of the antenna used, he would still have been limited in the resolution of the detected reflections.

A review of the 1980–1990 archaeological literature indicates a paucity of GPR investigations within Arizona. While Bevan's work in the early 1980s showed promise, and returned interpretable results verified by ground truthing, the use of GPR did not disseminate widely into the professional archaeological community. This may be related to the technical difficulty of performing GPR surveys with the rudimentary analog hardware used at the time.

In 1990, James McGill conducted extensive testing of the suitability of GPR on various sites in southern Arizona for his Master's thesis (McGill 1990). One of these was an historic site, the Presidio San Ignacio de Tubac, site AZ DD:8:33(ASM), dating to the Spanish Colonial-period (AD 1730–1865) in Tubac, Arizona. Here, McGill identified strong radar waveform reflections indicating a plastered floor at the Casa del Guardia, later confirmed by archaeological excavation. Walls were more diffuse, but still somewhat visible in the GPR data (McGill 1990:204–205).

Based on a geographical and temporally diverse sample of sites, McGill found that GPR was very useful for subsurface investigation of sites in southern Arizona. He concluded that the electrical conductivity of the soil controls radar waveform attenuation below 1 MHz and water content caused large increases in radar waveform attenuation near 100 MHz. The presence of clays in the soil increased the attenuation an order of magnitude lower to 1 MHz. Small increases in clay content significantly increased attenuation. He also inferred that soils in alluvial basins in southern Arizona have high cation exchange capacities and also are highly conductive, causing significant radar waveform attenuation. At higher elevations, the geology exhibits low clay content and high resistivity, which allows for productive use of the 500 MHz antenna. Sternberg and McGill (1994) recapitulate much of the knowledge that was gained in the early work completed by McGill (1990). In their discussion of previous GPR work in southern Arizona, they note that previous GPR surveys with 400 MHz antenna penetrate only short distances (approximately 1 m) in sediments of the basins of southern Arizona. The early investigations used low frequency antennas with poor resolution but had adequate depth penetration. However, the depth of penetration using these lower frequency antennas is only slightly higher than the higher frequency 400 MHz antenna (slightly more than 1 m). They conclude that the 400 MHZ antenna is most suitable for use in southern Arizona, because most archaeological features are buried less than 1 m below the surface.

In 1992, Carl Glass of the University of Arizona undertook additional GPR survey work at Mission San José de Tumacácori, which was being investigated under the direction of Jack S. Williams of the Center for Spanish Colonial Archaeology (SCA) (Ayres 1992:21). No published information is available on the results of this survey or other work conducted by the SCA. Work at the Presidio San Agustín del Tucsón , site AZ BB:13:13(ASM) (AD 1775–1876) was also conducted by Glass to determine whether any subsurface remains of the Tucson Presidio survived. Several areas were surveyed, including the courtyard of the Pima County courthouse, which resulted in promising radar signatures that may have indicated the remains of a wall (Thiel 2001:5). No other published information was identified documenting the results of this undertaking. Subsequent excavations, however, have located portions of the Spanish presidio's defensive wall in areas proximate to the GPR survey (Thiel 2004).

Finally, a GPR survey was conducted for a portion of the historic cemetery at the Pioneer and Military Memorial Park, situated within the larger prehistoric site of La Villa, site AZ T:12:148(ASM), just to the north of Cementerio Lindo. Investigations were conducted at the southwest and southeast corners of the historic cemetery, a north–south pathway, at the "Chinese Circle," and near the Jacob Waltz stake and monument (Glass 1994). High clay content in the soil limited radar signal penetration to the top 3.5 ft of the subsurface. Approximately 120 historic period grave shafts oriented both north–south and west–east were identified, as were several possible prehistoric canals. One other historic-period GPR survey in Arizona is known, conducted on the historic Q Ranch cemetery (Mark Hackbarth, personal communication 2016). However, results of this survey remain unpublished. Mention should also be made of the most recent work conducted in southern Arizona. While none of this work has been completed on Historic-period sites, but rather on Hohokam sites, this work has proven effective at imaging many types of subtle archaeological features using instrumentation much newer than that outlined above. This includes work near the Santa Cruz River in Tucson (Conyers and Cameron 1998) and work at Casa Grande Ruins National Monument by James Doolittle of the Natural Resources Conservation Service (Doolittle 2007).

Arizona archaeology has a long history of geophysical surveys extending back to 1978. However, the pattern of GPR use in Arizona could be characterized as a kind of "punctuated equilibrium," whereby GPR surveys occur as episodes of intense interest, followed by long periods of stasis. Indeed, the majority of the GPR work in Arizona has been conducted by only three researchers (namely Bevan, McGill, and Conyers). This small coterie of specialists is unfortunate, as the surveys demonstrate that the method has utility in determining the location, depth, size and perhaps function of various types of buried subsurface archaeological features, depending on local sedimentology. Since 1978, GPR has proliferated throughout the United States, but Arizona archaeologists have been slow to fully embrace this technique and more recent upgrades in technology. Moreover, historical cemeteries in Arizona present their own unique set of variables that could contribute to understanding of cemetery composition, organization, and differences in ethnic and religious burial customs.

GPR and Historical Cemeteries

GPR surveys within historical cemeteries have been used to: locate unmarked burials, find the extent of a cemetery, fit historic cemetery plats to their physical location, determine used/unused areas for cemetery management, cost assessments and planning for exhumations, and targeting exhumations and minimizing exploratory excavation (Jones 2008:26). Archaeologists also use GPR surveys in cemeteries to examine cultural patterns over time and space. Characteristics of the grave shaft and materials used to contain the human remains have specific waveform characteristics that can be analyzed to assess the types of burials.

The study of historical cemeteries presents unique challenges for archaeologists and non-destructive techniques such as GPR may be preferred for their study (Jones 2008:25). GPR can be particularly suitable for the detection of graves at cemeteries, as well as unmarked graves, if environmental conditions are ideal (Johnson and Haley 2005). Depending on the age of the burial, they can be easy or quite difficult to image with GPR. Modern burials are often readily visible, because of void spaces from caskets that return very high amplitude reflections (Conyers 2012:132). Modern cemeteries also usually follow a regular patterning of compact spacing (Potter and Boland 1992), which can also aid in interpreting the reflection profiles of subsurface interfaces. Older cemeteries can be much more difficult to image, due to the small target size of the burials, differences in burial depths, and decomposition of the casket and remains (Conyers 2012:137).

Graves have a variety of characteristics that potentially can be imaged using GPR. Some of these include weak reflections produced due to chemical differences of the decomposed remains and surrounding soil, very strong reflections due to void spaces within coffins, reflection caused by the truncation of stratigraphic layers as the grave shaft was excavated, and very high reflections from metal caskets (Bevan 1991:1310; Conyers 2012:132–133). However, in cases where the substrate and backfill material are fairly homogeneous, with little stratigraphy present, it can be difficult to image the contact between the shaft and the surrounding undisturbed soil. The depth, size and shape of a radar waveform reflection are the main indications that a reflection may be a grave; radar waveform reflections elongated in one direction relative to the perpendicular direction of the traverse may suggest a grave (Bevan 1991:1313, 1316). GPR can often determine grave attributes such as depth of burial, grave size, type of caskets and their orientation, and the quantity and spatial distribution of graves. These attributes may reflect differences in socioeconomic status, ethnicity, religious, or aesthetic values of the descendant community. However, the skeletal remains themselves generally are not detectable because of low contrast between the surrounding soil matrices and the remains, although Mellet (1992) has suggested that the decomposition of bones may leach calcium salts into the surrounding soil, which over many years could change the electrical properties of the soil, increasing the reflectivity of the remains.

Hyperbolic-shaped point-source reflections are generated from distinct point features in the subsurface, which in cemeteries are usually the tops of caskets or void spaces within caskets. Metal and wood caskets can be differentiated from GPR radar waveform reflections (Conyers 2013:188). Metal caskets produce both hyperbolic point-source reflections, as well as a series of distinct stacked reflections below the apex of the hyperbola. Wooden caskets and void spaces from collapsed caskets lack multiple reflections below their apexes, and the waveform reflections are narrower. Smaller hyperbolas are often generated from smaller caskets, such as those of child burials. In some cemeteries without caskets or with deteriorated wooden caskets, no distinctive hyperbolas will be generated. In these cases, only the contact between the vertical grave shaft and the natural soil matrices may be visible in reflection profiles as distinct truncation of the undisturbed adjoining material. Burials in wooden caskets are much more difficult to detect because the possibility for a strong contrast in RDP occurs at the bottom of the burial shaft, which will produce a reflection only if the shaft fill contrasts sufficiently with the undisturbed soil into which the shaft was dug (Stringfield et al. 2008). Thus, by using these waveform characteristics, coffin material, adult or subadult burial, and burial depth may be determined. The time-slice method is invaluable in spatially mapping graves and separating potential shafts from other disturbances such as rocks and roots (Goodman et al. 1995).

Cementerio Lindo GPR Survey

Goals of the Survey

The Cementerio Lindo GPR survey collected enough data to assess the utility of GPR to locate and define historic graves within the cemetery and more broadly, alluvial soils found in the Phoenix Basin. Work was conducted in judgmentally selected portions of the cemetery (Figure 6) to determine whether GPR surveys can locate subsurface soil interfaces that may be grave shafts or buried memorial markers. The survey also examined locations of known graves, as identified from the presence of memorial markers mapped by Montero et al. (2008:42), as well as areas lacking memorial markers. At the start of the survey we assumed that coffins could be present, but concrete vaults were not likely constructed. Because of their expense, vaults for coffins were unlikely to be constructed within an indigent cemetery. Both coffin and vault burials theoretically could be identified from the GPR survey results, but recognition of shroud burials would be unlikely. Our sampling areas or Survey Areas within the cemetery were selected for a variety of site-specific reasons, including differences in soil moisture, surface obstructions, and vegetation conditions.

Survey Area 1 consisted of one 20 by 20 m grid located in the northeast corner of the cemetery. This portion of the cemetery was close to the original road that linked the cemetery with the OPT and may contain older burials. It was hypothesized that all thing being equal, the 1890s undertakers may have used the area closest to the road first to minimize their efforts; later burials would tend to be farther from the access road. Archival records indicate that some early burials were marked with fired bricks that might be identified by a subsurface reflection. Survey Area 2 was in the central portion of the cemetery, with Survey Areas 3 and 4 contiguous and to the east. These three survey areas were established to test locations where alluvium may have collected behind the raised roadway. The natural

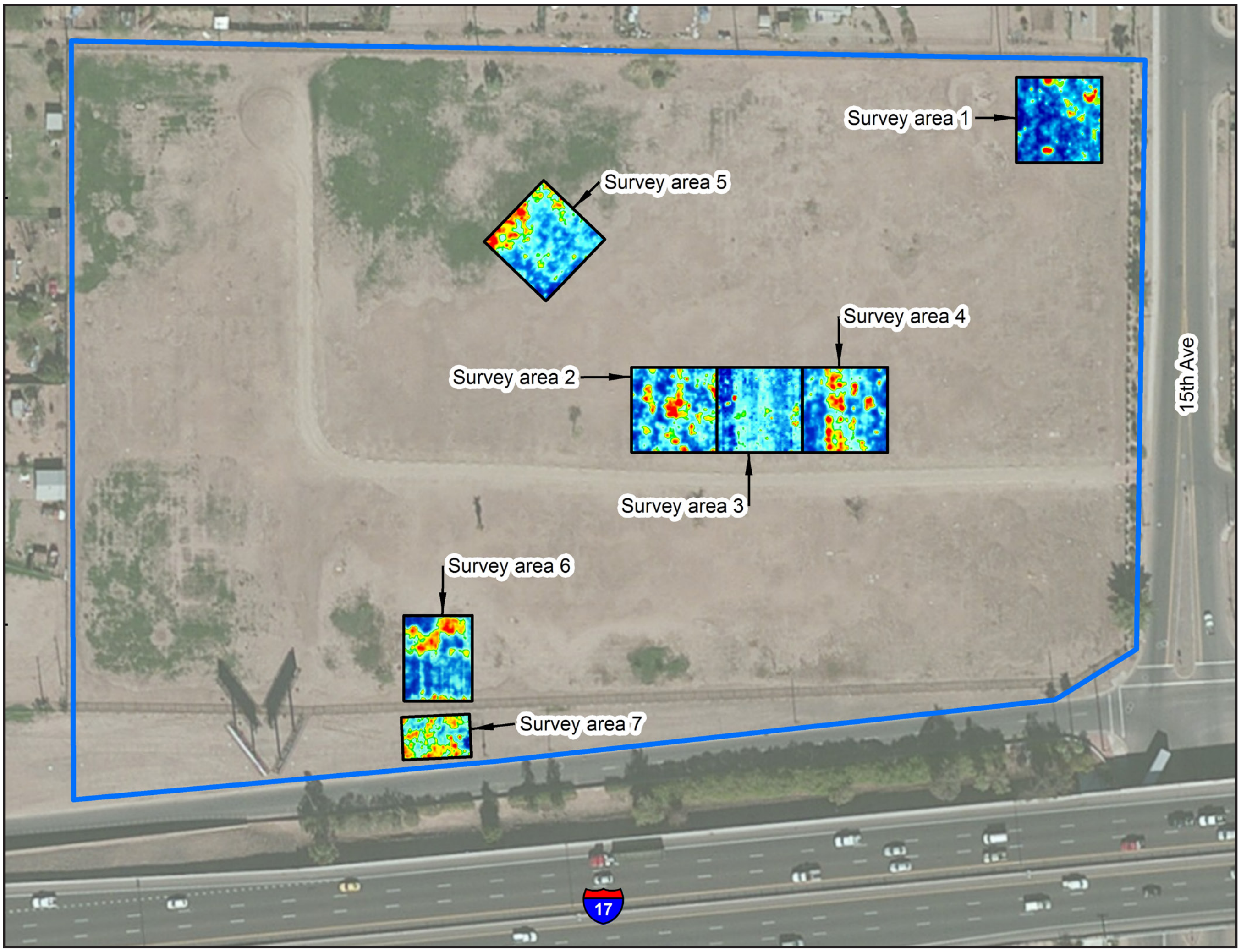

Figure 6. Post-processed results of Survey Areas.

topography would cause water to flow from north to south, which would have collected sediment along the north side of the access road. Fine silt deposited by surface water flows may attenuate GPR radar waveform reflections. The three contiguous survey areas also have areas with and without surface memorial markers. Survey Areas 2, 3, and 4 also provide an opportunity to explore contiguous blocks where parallel rows of graves could be expected and have a consistent and uniform spacing, leading to the opportunity to recognize spatial patterns where buried memorial markers could be expected.

Memorial markers were observed on the surface of Survey Areas 3 and 4 and were expected to "calibrate" our search for graves and suggest what radar reflections would look like for a grave. Survey Area 5 was located northwest of Survey Area 2, in an area with dirt and vegetation exposed on the surface; the weeds and grass were mowed before the survey, leaving stubble approximately 1–2 inch high. This area had no memorial markers but likely retained higher ground moisture, as indicated by the presence of vegetation that survived without irrigation. The area with elevated soil moisture was included in the sample survey to contrast with areas of less moisture to determine the effectiveness of the GPR survey with differential soil moisture. Survey Area 6 was selected for multiple reasons: a nearby Palo Verde tree may indicate relatively high soil moisture; it was south of the access road that would have blocked surface runoff flowing over the cemetery and inform about potential soil moisture issues; and it is also at the farthest point away from Survey Area 1, but still within the original 10-acre square of the early cemetery and could have early burials if the 1890s undertakers were instructed to use the area farthest from Phoenix for the first graves. Survey Area 6 is in the southwest corner of the original cemetery and some oral histories suggest the western area of the pre-1930 cemetery may have the earliest graves. Finally, Survey Area 6 was immediately north of the modern cemetery boundary fence and was selected to serve as a comparative study for Survey Area 7, which was located immediately outside the cemetery fence and south of the current cemetery boundary, between the I-17 frontage road and the cemetery; it was selected for investigation because it had a moderate density of surface rock and was adjacent to the original cemetery land that was exchanged in the 1930s. The original plan was to place Survey Area 7 farther to the east, but surface rock along the cemetery fence (east of Survey Area 7) formed a continuous pavement. The continuous surface rock cover was expected to attenuate GPR signals. A survey outside of the current cemetery boundary was desired to test the hypothesis that grave shafts may be located outside of the cemetery fence. Oral histories of the cemetery (Reynolds 2008) included anecdotal accounts of human remains discovered during construction of utilities within the frontage road and I-10 corridor; therefore, Survey Area 7 was anticipated to test a part of the pre-1930 cemetery that may have human remains, but is currently a buffer between the frontage road and the cemetery fence.

Research Questions

Effectiveness of GPR survey

The primary research question is a methodological study of the effectiveness and utility of GPR survey within Cementerio Lindo. The cemetery is on the distal end of an alluvial fan and the landform intergrades with alluvium from the Salt River floodplain. Previous research in Arizona has indicated that alluvium may attenuate GPR signals, which could hinder the discovery of graves shafts or buried memorial markers in Survey Areas 1–7. In addition, the moisture content of soil may attenuate GPR signals and high soil moisture could limit the effectiveness of GPR survey. Therefore, the GPR sample survey addressed the broad question of whether GPR survey is effective at locating graves in the alluvial sediment of the cemetery.

The alluvium of Cementerio Lindo was not expected to include naturally occurring rock or other large, dense inclusions. Therefore, buried memorial markers of stone, concrete, metal or other dense materials could produce GPR reflections that could be interpreted as the location of a memorial marker or grave shaft. Memorial markers placed flush with the ground in the 1960s were expected to be shallowly buried, which would allow even attenuated GPR signals to locate graves. The effect of high and low soil moisture content to affect the GPR signal was tested within the cemetery at multiple locations. Areas with relatively high soil moisture, as indicated by abundant plant growth (Survey Area 5) and areas where water may collect (Survey Areas 2, 3, and 4), were contrasted with areas lacking vegetation (Survey Areas 1 and 5). The survey examined spatially separate portions of the cemetery where surface markers indicate graves were present, as well as adjoining areas that lacked surface markers.

Cemetery Spatial Organization

Archival records indicate Cementerio Lindo was divided into sections, blocks, lots, and rows with each grave assigned a unique number. However, the organizational plan of the cemetery and other written information was destroyed in a fire. The oral histories collected about the cemetery imply that most graves were added sequentially and that groupings of family or ethnic groups are not present, although some people mentioned their family members were buried together. No archival information was found to suggest that the cemetery had sections reserved for members of different religious, race, or ethnic group, but sections of the cemetery were reserved for children that allowed smaller grave sites to maximize the space for graves in the cemetery (see Appendix A, Montero et al. 2008). The previous survey of the cemetery (Montero et al. 2008) identified a pattern of burials placed in north–south rows with each row of burials a regular distance apart (roughly 10 ft). Graves of children are in at least two portions of the cemetery, and Craig (1986) identified one location where the orientation of graves differs from most of the cemetery, which could be a third location reserved for children. The GPR addressed three questions regarding spatial organization:

- What is the spatial organization of graves within the judgmentally selected Survey Areas?
- Is the distance between rows of graves consistent?
- Are some graves smaller than others and possibly used for juveniles?

Block GPR surveys were conducted in different portions of the cemetery. Locations near the western end of the pre-1930 cemetery boundary were surveyed because of the near total absence of surface markers in this area (Survey Areas 5 and 6). Oral histories indicate the western area of the pre-1930 cemetery and the southeast section had the earliest graves. Although some surface markers are present in the western portion of the cemetery (added in 1930), the placement and orientation of rows in this area cannot be confirmed from the few remaining surface markers, and the GPR survey was not conducted west of the north–south access road that marks the limits of the 1930 addition. A block survey was used to sample an area with possible high soil moisture conditions and an absence of surface markers (Survey Area 5), as determined from annual weeds and low-lying portions of the cemetery. Survey Areas 2–4 had multiple rows of surface markers visible that would make it possible to assess the spatial organization of the cemetery. The survey blocks were sufficiently large (20-m by 20-m) to encompass three or more rows of graves, if graves were approximately 10-ft long; the contiguous blocks ensured multiple rows would be captured during the survey.

Cemetery Formation Processes

Archival evidence from 1894 indicates 11 early burials were marked with fired bricks. Oral traditions suggest the oldest graves were in the west (Survey Area 6) and southeast portions of the cemetery. Alternatively, the northeast corner of cemetery (Survey Area 1) is closest to the OPT and may have been used for the earliest graves if the undertakers expended the least amount of effort when transporting and burying the deceased. Early burials marked with fired bricks may be recognized as strong GPR reflections returned by the bricks. Survey Area 6 was established in the southwest portion of the pre-1930s cemetery and Survey Area 1 in the northeast corner to search for early graves marked with bricks. Sand-blasted slabs of concrete were used to mark some graves in the 1960s. Graves marked with 1960s concrete slabs may be recognizable from a consistent-sized slab and shallow depth in any of the survey areas. Oral histories indicate that trenches excavated for the I-10 highway encountered some human remains (Reynolds 2008). The GPR survey of Sample Area 7 examined an area close to the I-10 frontage road to search for burials outside of the current cemetery boundary. The GPR survey may address questions of grave locations that may have become obscured over time.

- Are shallowly buried memorial markers evident?
- Are the GPR reflections suggestive that some memorial markers have been moved and are offset from grave sites in rows of burials?
- Are there GPR reflections from subsurface interfaces suggestive of grave shafts or memorial markers near the I-10 frontage road?

The GPR survey inspected areas that may be within earlier portions of the cemetery, as suggested by oral traditions (Survey Area 5) versus proximity to the OPT (Survey Area 1). The earliest graves were expected to have a high amplitude reflection because of the presence of fired bricks. The fired brick was hypothesized to return a reflection distinguishable from other forms of markers. The survey areas were large and extensive enough (16–20 m on a side) to encounter multiple rows of burials if they were oriented north–south. The interval between survey transects (0.5 m) provided 100% coverage within the survey areas. Memorial markers were observed on the surface within some survey areas, which allows spacing between rows to be determined independent of the GPR. The GPR survey was employed close to the I-10 frontage road to assess whether burials may be outside the cemetery fence (Survey Area 7).

GPR Survey Instrumentation and Methods

The GPR survey at Cementerio Lindo utilized a GSSI Subsurface Interface Radar (SIR)-3000 GPR system, composed of a control unit with an internal data logger and a transmitter and receiver mounted on a 3-wheeled survey cart, connected to a 400 MHz single-frequency antenna. The GPR system settings were set to record high-resolution waveform reflections, with 512 samples per scan and 120 scans per second. Care was taken to set the range gain to an appropriate level; a level set too high can clip data if waveforms are recorded with higher than expected amplitudes (Conyers 2013:101). Thus, field range gain was set at a moderate 4 points to amplify radar waveforms received from deeper underground. The location of the survey areas were uploaded to a Trimble GeoXH GPS prior to survey and then located in the field. The corners of all survey areas were marked with wooden stakes; fiberglass tapes with each meter marked in red paint were stretched between the survey area corners to orient the survey transects. The GPR followed the north to south oriented fiberglass tapes. Data was collected along the X-axis only, using a zigzag-pattern of traverse intervals of 0.50 m aligned to grid north. At the end of the survey, all wooden stakes marking the corners of the survey areas were pounded flush with the modern ground surface. Six of the survey areas were oriented to cardinal directions and the GPR passed along the north to south axis of the survey area, perpendicular to the likely orientation of grave shafts (east to west). This approach was used because linear features such as grave shafts are better resolved when approached perpendicular to a known orientation (Dionne et al. 2010:20; Pomfret 2006). One 20-m by 20-m grid (Survey Area 5) was oriented approximately 45 degrees off of cardinal directions as a test of the GPR instrumentations ability to recognize grave shafts if not encountered perpendicular to the grave's long axis, and to sample an area with evidence of dry soil as well as where soil moisture was retained, as determined by the growth of vegetation.

GPR Signal Processing Procedures

After the GPR field work, the author used GPR-Slice software (Geophysical Archaeometry Laboratory), and ArcGIS (ESRI) to complete all post-field signal processing, visualizations and interpretations. Post-field signal processing consisted of the procedures outlined in Table 2 and discussed in greater detail below. Amplified signals recorded without a frequency bandpass filter will drift away from the 0-line, as low frequency noise is amplified during post-field range gaining application. This drift or "wobble" is removed using a windowed moving average along the radar pulse, which is subtracted from the center at each point along the pulse (Goodman and Piro 2013:38–39). Next, time-zero was corrected and truncated, before automatic gain control and bandpass filtering was completed. Application of a bandpass filter allows the analyst to focus attention on only a specific portion of the radar pulse frequency and remove high and low frequency noise. Bandpass filtering requires that the radar pulses first be converted to the spectral domain using a Fast Fourier Transform (FFT) to calculate the amplitudes and phases at different frequencies. Once the signal is decomposed into its spectral components, the amplitudes of different pulses are adjusted by suppressing or enhancing the desired frequency (Goodman and Piro 2013:40–42). Generally, frequencies below 180 MHz and above 500 MHz were removed.

Background noise removal was then completed to eliminate the obscuring effect of horizontal banding across the reflection profile by calculating the average pulse across the entire reflection profile and then subtracting this average from the individual recorded pulses. While using the background removal filter can remove linear features of interest parallel to the profile traverse (Goodman and Piro 2013:46–48), when such features are perpendicular to the traverse, it is generally safe to initiate background removal without fear of removing these linear features. The north to south survey transects were expected to be perpendicular to graves at Cementerio Lindo, except in Survey Area 5. After the background filter was performed, a Hyperbola search was completed for Kirchhoff Migration to move the reflections to their proper locations before a Hilbert transform was completed on the Bandpass filtered data. This was used to display the envelope of the radar pulses using a FFT, to show regions of weak or strong reflections that more closely represent the structure of the subsurface than a raw radar pulse. Using a Hilbert Transform on reflection profiles also allows for thinner time-slices (Goodman and Piro 2013:53–54). After these signal processing procedures were completed, the reflection profiles were sliced and gridded, and a 3 by 3 Boxcar Lowpass filter was applied to the gridded data to smooth noisy time-slices resulting in a smoother time-slice. Slicing the interpolated reflection profiles results in a series of horizontal images across the survey grid, which is analogous to a "plan-view" image of the subsurface. These slices can be generated at various thicknesses and depths depending on the reflections present within the survey grid and the expected depth of features of interest. After all visualizations were rendered, ArcGIS compatible rasters were exported to allow for display of the relevant surveyed areas in real space.

Table 2. Signal-processing Procedure Workflow

Signal Processing Procedure	Process Order
DC Drift wobble removal	1
Time -0 correction and truncation	2
Range gain and Bandpass filtering	3
Background noise removal	4
Kirchhoff migration	5
Hilbert transform	6
Time-slicing	7
3 X 3 boxcar Lowpass filter	8
Time-slice output raster to GIS	9
Spatial Analysis and data overlay	10
Interpretation	11

GPR Survey Results

We believe the question of whether GPR survey in Cementerio Lindo is an effective method for the discovery of the location of graves in an alluvial setting has been answered positively. Although portions of each survey area have ambiguous results, overall, the results are strongly patterned and suggest positive identification of buried memorial markers and potentially grave shafts. These results (see Figure 6), however, were not evident without signal processing. Prior to signal processing, the data were very noisy. This noise was likely due to the high conductivity of the local soil. Noise in GPR data is common and some can be removed using proper signal processing tools. It should be noted that very few hyperbolas were visible on-screen while collecting data in the field. Only after processing the data and performing time-slices were some point-source reflections evident that correlate to the locations of in situ memorial markers.

Despite the extensive signal processing, some locations have no apparent evidence of reflections, or only very low amplitude reflections. In the following discussions, we use time-slices at an estimated depth of approximately 1 m to discuss our interpretation of a subset of reflections, and thus the organization of the cemetery. This depth was chosen as the best approximation of the depth an intact burial feature may be visible. We believe reflections that are present at or near the surface are likely to represent burial markers. For our discussion of what constitutes a row of graves, we preferred three reflections in a line, although in some circumstances fewer reflections then three were used.

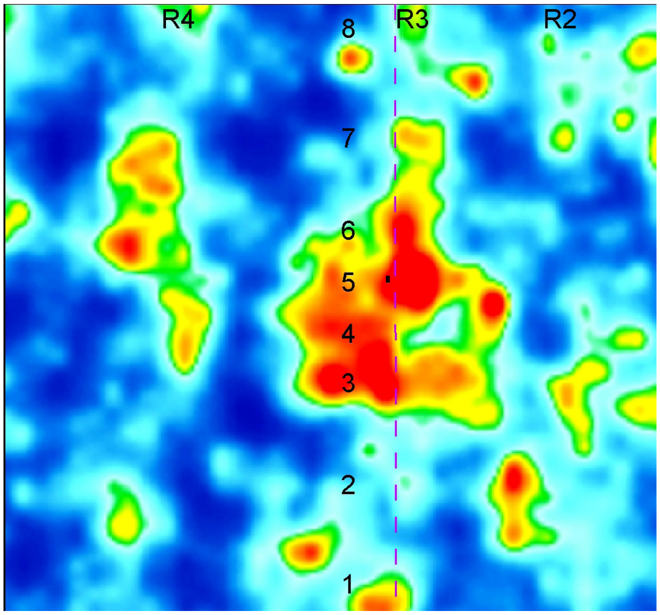

Figure 7. Post-processed time-slice of Survey Area 2 at 1 m depth.

Survey Area 1

Survey Area 1 has one surface memorial marker that is associated with a moderately high amplitude reflection as mapped by Montero et al. (2008) (see Figure 6). The highest amplitude reflections (red to yellow in all time slices) are not in precise rows, which may suggest a relatively haphazard approach to placement of burials, much like the first City of Phoenix cemetery, in use from 1871–1885 (Hackbarth 2012). However, there are several lower amplitude reflections (yellow to green in all time slices) that may also represent graves or buried bricks, rocks used as memorial markers, or reflections from interfaces at natural soil features. The high amplitude reflections suggest Survey Area 1 may contain four rows of burials organized in north to south alignments. The only surface marker in Survey Area 1 is associated with a weak reflection in the northeast corner of the survey area. Survey Area 1 has two unusual north–south aligned reflections near its eastern and southern edges that could suggest some graves were oriented north to south, not east to west. Alternatively, these reflections could be the result of overlapping graves, disturbances, or possibly prehistoric or natural soil conditions. However, because they are in rows, our preferred explanation is they represent east–west graves that are close together, possibly with overlapping grave shafts.

Survey Area 2

Survey Area 2 has seven surface memorial markers with four associated high amplitude reflections that form four rows of graves and a possible fifth row along the western boundary (Figure 7). Two memorial markers in Row 1 are close to each other, with one large associated reflection. One explanation is that juveniles and adults were placed in the same row and the smaller reflection indicates a grave for two juveniles buried near each other that appears as a single reflection. The purple dashed line at Row 3 indicates the location of Figure 8, a reflection profile illustrating 8 high amplitude reflections (all reflection profiles are after time-0 truncation, Bandpass filtering, and Background removal). Reflections 1 and 2 appears to originate near the surface, and likely represent surface or shallowly buried markers. Reflections 3 and 4 originate near 12 ns and may represent graves or deeply buried markers. Reflection 5 is a high amplitude reflection and originates at or near the surface, and likely represent intact memorial markers, probably containing metal based on the antenna ringing apparent throughout the reflection profile. Reflections 6 8 originate near 12 ns and may represent graves or deeply buried markers.

Survey Area 3

Survey Area 3 has four well defined rows of memorial markers, two near the eastern edge and two near the western edge of the survey area, totaling 22 markers (Figure 9). Fourteen of the markers have associated high amplitude reflections, while the remaining have low amplitude or no associated reflections. The distance between surface markers in the same row (north–south) is somewhat consistent, averaging 1.7 m (5.6 ft). In one instance, the surface markers are only 0.8 m (2.6 ft) apart. The rows of surface markers are 3.7 m (12.1 ft) and 2.2 m (7.2 ft) apart (east–west). Rows 3 and 4 in Survey Area 3 have few high amplitude reflections and no surface markers evident, with several low amplitude reflections that may represent ephemeral graves without caskets or with wooden caskets. Row 6 has the most consistent patterning of high amplitude reflections. The purple dashed line at Row 6 indicate the location of Figure 10, a reflection profile illustrating 8 high amplitude reflections. Reflection 1 appears to originate near the surface, and likely represents a buried marker. Reflections 2 and 3 originate near 15 ns and may represent graves or deeply buried markers. Reflections 4 and 5 appear to originate near the surface, and likely represent intact memorial markers, probably containing metal. Reflections 6 and 7 originate near 15 ns and may represent graves or deeply buried markers. Reflection 8 originates near 5 ns and likely represents a buried marker.

Survey Area 4

As with the adjacent Survey Area 3, Survey Area 4 contained many surface memorial markers (n = 38). Thirty-seven of these markers form five rows oriented

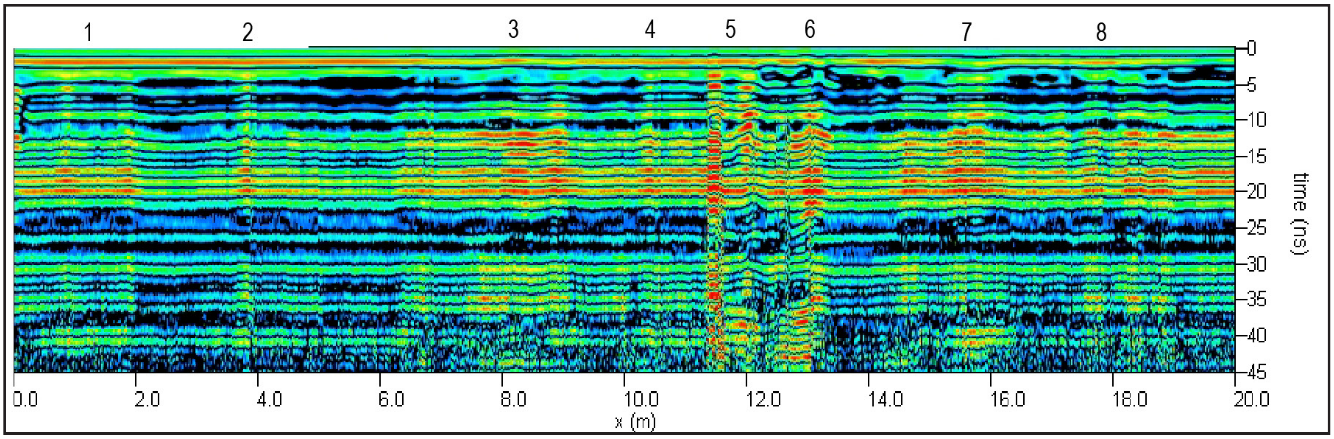

Figure 8. Example reflection profile of Row 3.

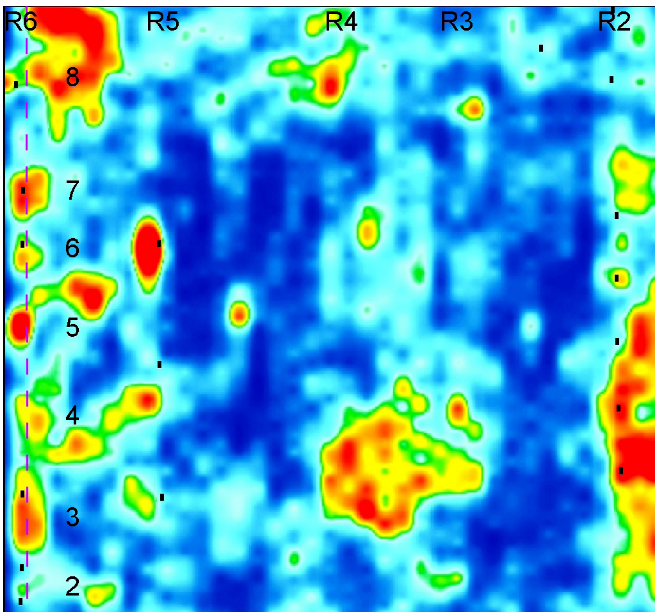

Figure 9. Post-processed time-slice of Survey Area 3 at 1 m depth.

north–south (small black rectangles). One surface marker is present in Row 6 (Figure 11, top left). The distance between rows of surface markers is inconsistent and varies from 2.4 m (7.9 ft) to 3.3 m (10.8 ft). Twenty-eight of the high amplitude reflections with associated surface memorial markers extend beyond the memorial marker's location, suggesting a grave or metal may be present at or near the surface. Ten memorial markers have no associated reflection. This survey area demonstrates the best association between surface memorial markers and high amplitude reflections. Rows 4 and 5 have most memorial markers present with associated reflections (n = 17). Rows 1 and 2 contain eight surface memorial markers with no associated reflection present. This may indicate these markers are out of place from their original location; alternatively, local soil conditions at these locations may not have been suitable to provide enough contrast for the GPR signal to identify a buried feature. The purple dashed line at Row 5 indicates the location of Figure 12, a reflection profile illustrating 7 high amplitude reflections. Reflections 1 4 originate at or near 3 ns, and likely represent surface or shallowly buried memorial markers, probably containing metal. Reflections 5 and 6 originate at approximately 17 ns, while reflection 7 originates at approximately 12 ns. These reflections likely represent graves with a casket, possibly containing metal fixtures, or buried memorial markers with metal.

Survey Area 5

Results from Survey Area 5 strongly suggest that soil moisture, as evident from the growth of annual weeds and grasses, contributes to high amplitude reflections in the western portion of the unit (see Figure 5). However, some of the high amplitude reflections present at the east end of this survey area are suggestive of graves based on size, shape, and orientation. The west edge of Survey Area 5 had the highest amplitude reflections and the most growth of vegetation. The orientation of the survey area was intentionally angled away from the standard north–south and east–west orientation to assess the difficulty of recognizing graves if the antenna did not encounter them at a perpendicular angle. As expected, the reflections became elongated and our ability to recognize a precise break between rows was reduced because of overlapping signals (cf. Dionne et al. 2010:20; Pomfret 2006). Rows of reflections are not evident and the higher moisture content in this area likely accounts for many of the reflections. However, several graves or buried markers may be the source of reflections on the eastern edge of the survey area.

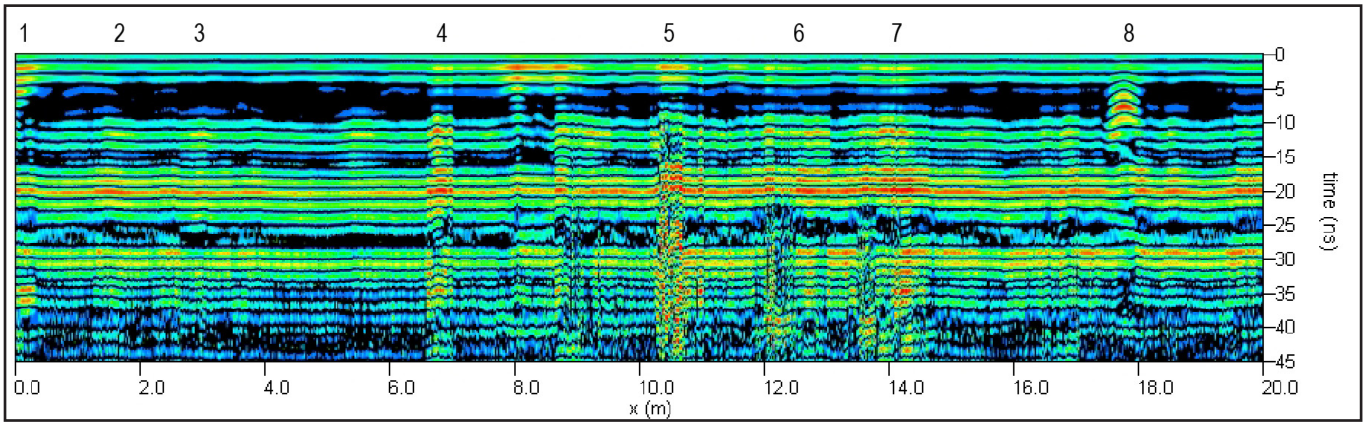

Figure 10. Example reflection profile of Row 6.

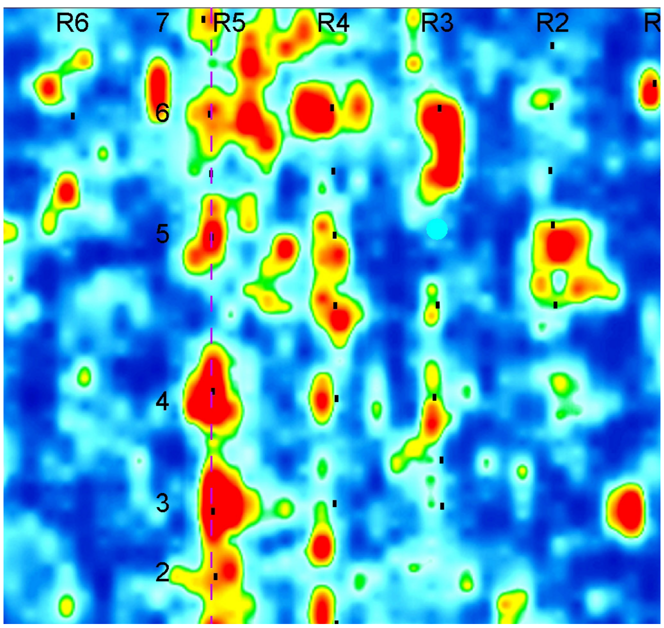

Figure 11. Post-processed time-slice of Survey Area 4 at 1 m depth.

Survey Area 6

Five rows of standard width are present, located at the west and east ends (see Figure 12). This survey area was smaller than the standard 20-m by 20-m size due to a large tree present at the western edge and a large surface memorial marker at the eastern end. The areas surrounding the tree and marker were avoided for ease of survey. Reflections in the northern portion of the unit seem to overlap significantly, which suggests they are due to reflections at interfaces of natural soil features, and thus may not represent graves. Vegetation was present at this location at the time of the survey. However, they may also be indicative of caskets containing metal, or possibly with intact voids. High amplitude reflections form ambiguous rows in the north half of the unit. High amplitude reflections also are present along the southern edge of the survey area but are truncated by the survey area boundary. One large surface memorial marker was present in this survey area, located in Row 4 (Figure 13).

Survey Area 6 has the fewest reflections of any survey area in terms of absolute numbers (n = 26), less even than Survey Area 7, the smallest survey area (see discussion below). Survey Area 6 is 20% smaller than Survey Areas 1–5, and the south end of the survey area was bounded by a modern chain-link fence. The survey area was triangulated to allow for the final 0.50 m section of each traverse to be surveyed by the antenna, with the front wheel of the cart just touching the cemetery fence. The truncated reflections along the southern edge may be evidence that burials are located south of the cemetery fence, or minimally, directly under the fence. Allowing for this size difference, the proportion of square area in meters to the number of reflections identified is relatively equivalent with the other survey areas.

Survey Area 7

Survey Area 7 was the smallest unit of all sampled survey areas. This was because we wanted to keep the east–west survey width identical to Survey Area 6 immediately to the north, but the north–south area available to survey was bounded on the south by the I-10 frontage road (W. Maricopa Freeway) and to the north by the same fence bounding the south edge of Survey Area 6. Previous oral history research indicated human remains were encountered during construction of the I-10 corridor located 20 m to the south of the survey area (Reynolds 2008). Numerous high amplitude reflections are present throughout the survey area. However, the presence of surface rock, possible existence of subsurface disturbances, as well as possible presence of modern utility lines and other modern or natural soil disturbances, may be responsible for the various high amplitude reflections. Forty-nine

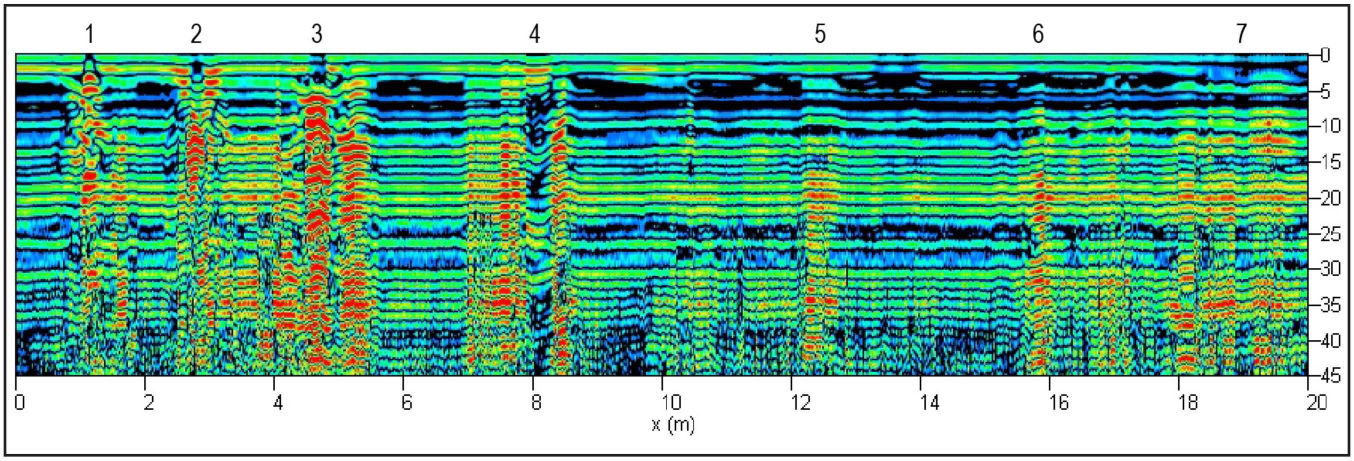

Figure 12. Example reflection profile of Row 5.

reflections were identified within this survey area, greater than the number of reflections that were identified at any other survey area. However, Survey Area 7 is 40% of the size of the other standard 20-m X 20-m^2 survey areas (160 m versus 400 m^2). The higher number of reflections located outside of the cemetery-proper is again indicative of natural or modern disturbances rather than the presence of historic graves, as is the lack of distinct boundaries between many of the features, and the agglomerative nature of the features. Many of the reflections in Survey Area 7 tend to be smaller than what we interpret to be likely graves in the other survey areas. In conjunction with the surface rock, this suggests many or all the reflections are natural soil differences or modern disturbance rather than graves.

Discussion of Results and Research Questions

The current survey has demonstrated the utility of GPR to identify the location of buried memorial markers and potentially associated graves within historic cemeteries in alluvial souls of the Phoenix Basin. Recent excavations at the first city cemetery recovered evidence of badly deteriorated coffins, and occasionally, coffin hardware, including nails, handles, and textile fragments (Hackbarth 2012). The orientation of rows in this early cemetery was highly irregular and may serve as an analog for the arrangement of early burials in Cementerio Lindo. The survey of Area 1 provided insufficient information to conclude that it is in an earlier portion of the cemetery than the surrounding areas, however the lack of discernable rows, and few reflection alignments suggest this may still be a possibility.

It is likely that most graves have too little difference in RDP to contrast with the surrounding soil matrix and generate a visible reflection. Some cemetery rows may be evident from low-amplitude reflections, but most of the high amplitude reflections are likely generated from buried metal coffin hardware, possibly intact voids, and shallowly buried or surficial memorial markers. The average extent of the highest amplitude reflection is relatively consistent at 1.5 by 2.0 m, which suggests a grave large enough to accommodate an adult lain supine or prone. Smaller reflections are common and appear as little more than 0.5 m in diameter, or larger. The difference

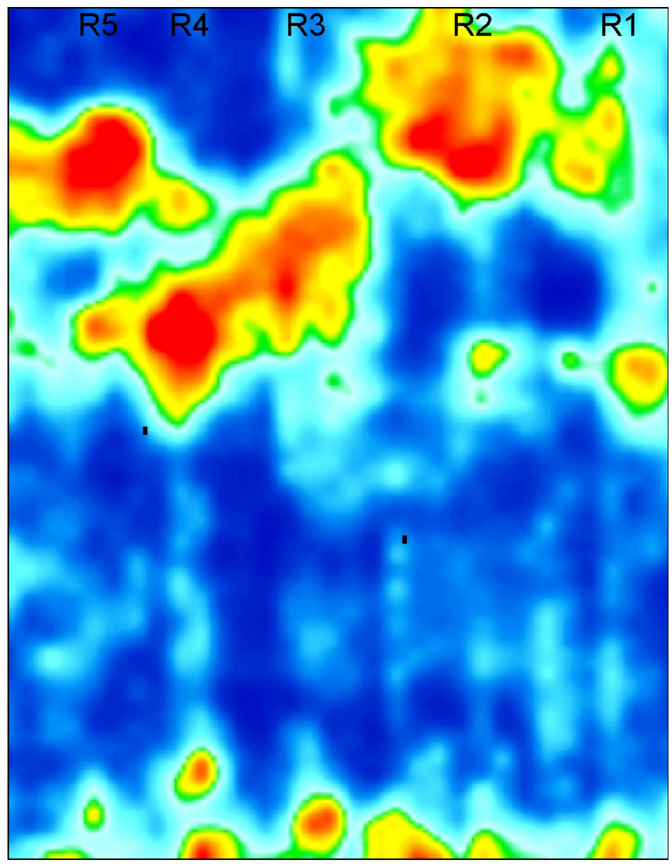

Figure 13. Post-processed time-slice of Survey Area 6 at 1 m depth.

between these small and large reflections could represent how the individual was interred (shroud versus coffin) or perhaps some highly contrasting elements of the grave, such as void spaces, metal name plates attached to the coffin or coffin hardware (nails, tacks, handles, glass viewing pane). They may also represent buried memorial markers, natural features or historical or modern disturbances.

The GPR survey has confirmed that the graves at Cementerio Lindo are organized in rows oriented north–south. Each row is approximately 10 ft wide (east–west), which equates to approximately 6 to 6.5 rows per survey area, on average. However, the distance between rows of surface headstones mapped by Montero et al. (2008) was not uniform. In Survey Area 3, the two easternmost rows of headstones are 2.5 m apart but the memorial markers at the western most side of Survey Area 3 are 3.85 m apart, which demonstrates that the distance between rows varies, or the markers were offset from the grave when placed flush with the ground in the 1960s. The reflections within the examined Survey Areas have a long axis that is east to west. The average north–south spacing between graves in the same row, as determined by surface memorial markers, varies from 0.88 to 3.19 m, with a modal distance of 1.65 m. Whether this north–south difference between surface headstones is a result of difference in grave sizes or a product of placing the memorial markers flush with the ground in 1967 irrespective of where the grave shaft was cannot be assessed from the GPR survey.

Perhaps the more common reflections in Survey Areas 2–4, in contrast to Survey Area 1, are reflective of the soil types in the two areas. Survey Areas 2–4 are next to the access road that effectively cuts off surface water flows across the cemetery. This difference, in terms of water content and soil may account for the greater number of interface reflections that occur near the access road than in the northeast corner of the cemetery.

The signal amplitude at locations with surface memorial markers is not uniformly identical. Although most surface memorial markers produced high amplitude reflections in Survey Area 2 and Survey Area 4, the markers in Survey Area 3 are not associated with high amplitude reflections. This may indicate that some surface memorial markers remain in situ, accurately marking a grave location. However, surface memorial markers with no associated reflection may have migrated from their original location, and no longer mark a subsurface grave. A total of 41 surface memorial markers have associated subsurface reflections, while 20 surface memorial markers have no associated subsurface reflection apparent. This indicates that most surface memorial markers (67.2%) have associated subsurface reflections identified as representative of possible graves, indicating that most of the surface memorial markers within the survey areas are in situ and likely correctly marking a grave. However, the remaining 32.8% of surface memorial markers have possibly migrated from their original locations and may no longer be marking a grave. As noted above, low amplitude reflections are quite common throughout the data set. It is not possible to determine if these low amplitude reflections represent buried memorial markers, juvenile graves, natural features, or historical or modern disturbances. Ground-truthing a sample of these reflections would determine what they may represent.

Many reflections were identified in the area south of the existing Cementerio Lindo chain-link fence marking the current property boundary. This area is approximately 20 m north of the I-10 corridor. Several of these reflections are suggestive of subsurface burials. However, the higher number of reflections located in Survey Area 7, outside of the cemetery-proper may also be indicative of natural or modern disturbances rather than the presence of historic graves, as is the lack of distinct boundaries between many of the features. Many of the reflections in Survey Area 7 tend to be lower amplitude than what we interpret to be likely graves in the other survey areas and based on the ordered row spatial organization. In conjunction with the surface rock, this suggests many or all the reflections were produced by natural soil horizon interfaces or disturbance rather than graves.

CONCLUSION

The GPR survey of Cementerio Lindo was undertaken as a methodological study exploring judgmentally selected locations of the cemetery to assess the utility of GPR to locate and define historic graves within the alluvial soils found locally. Work was conducted in the location of graves that are known from the presence of memorial markers (Montero et al. 2008:42). Numerous reflections were identified that may represent potential graves and buried memorial markers, demonstrating the utility of GPR surveys to identify these features. Not all likely graves had high enough contrast with the surrounding soil matrix to produce a high amplitude reflection. Some cemetery rows are evident from low amplitude reflection. However, the high conductivity of the local soil and inherent noise not filtered out from the data set make interpretation of the reflections difficult. Due to the presumed high conductivity of the local soil, depth penetration was just adequate. This conformed to our expectations based on previous use of GPR on desert soils in Arizona. However, penetration was good enough to adequately define many reflection profiles that likely represent features of interest. Because most features in the Phoenix Basin are not deeply buried, this may not be a severe issue for future GPR surveys in Phoenix.

The raw data produced in the field was inadequate to flag reflections in real time (i.e., during the field-work). Construction services and utility location often use real-time flagging to mark GPR reflections. The archaeological data, however, needed post-processing to be interpretable; specialized software removed noise with proprietary algorithms, to identify potential sub-surface reflections that may represent intact graves or memorial markers. While this is not problematic, it does require some expertise. The GPR survey at Cementerio Lindo confirmed that probable graves are organized in rows oriented north to south. Each row is approximately 10 ft. wide (east–west), which equates to approximately 6 to 6.5 rows found in our Survey Areas. However, the distance between rows of surface memorial markers was not uniform throughout the cemetery (Montero et al. 2008). The graves within the examined survey areas have long axes that are oriented east to west. The average north–south spacing between graves in the same row, as determined by surface memorial markers varies from 0.88 to 3.19 m, with the modal distance 1.65 m. Whether this north–south difference between surface markers is a result of difference in grave sizes or a product of placing the memorial markers flush with the ground in 1967 (irrespective of where the grave shaft was) cannot be determined from the GPR survey.

The amplitude of the reflection at locations with surface memorial markers was not uniformly identical. Although most surface memorial markers produced high amplitude reflections, the surface markers in other areas did not always produce a reflection. This may indicate that some surface memorial markers and associated subsurface reflections mark the location of a grave. However, surface memorial markers with no associated subsurface reflection may have migrated from their original locations, and no longer mark a subsurface grave. In our sample, 67.2% of the memorial markers had associated subsurface reflections identified as representative of possible graves, indicating that most of the surface memorial markers within the survey areas are in situ and probably mark a grave. However, the remaining 32.8% of surface memorial markers have possibly migrated from their original locations and may no longer be marking a grave shaft. As noted above, low amplitude reflections are very common throughout the data set. It is not possible to determine if these reflections represent buried memorial markers, juvenile graves, natural features or historical or modern disturbances. It is possible that all these interpretations are valid. However, ground-truthing a sample of these reflections would be required to determine what they may represent. Many reflections were identified in Survey Area 7, south of the existing Cementerio Lindo fence marking the current property boundary. This area is approximately 20 m north of the I-10 corridor. Several of these reflections are suggestive of subsurface burials. However, the higher number of reflections located outside of the cemetery-proper may be indicative of natural or modern disturbances rather than the presence of historic graves. The lack of distinct boundaries between many of the features, and the agglomerative nature of the features support this conclusion. In addition, many of the reflections in Survey Area 7 tend to be smaller than what we interpret to be likely graves in the other survey areas. In conjunction with the surface rock, this suggests many or all the reflections are natural soil differences or modern disturbance rather than graves. We believe that GPR has utility as an additional tool in our toolkit, which enables archaeologists a non-destructive view beneath the surface, even in soils traditionally consider “unsuitable”. While soil type, moisture content, RDP, and conductivity all present their own issues that must be overcome when utilizing this tool, modern instrumentation and signal processing procedures can produce useful and worthwhile results worth the effort.

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LAND OF THE BUZZARD CLAN AND THEIR MOBILE NEIGHBORS: EXPLORING THE PROTOHISTORIC IN THE SOUTHERN SOUTHWEST

Deni J. Seymour

A long-standing informational void once characterized the southern Southwest during the so-called protohistoric period. A generation of focused research has revealed that the apparent absence of evidence is not evidence of absence. Low visibility is no longer equated with inconsequential. Impactful and unconventional peoples have for too long remained at the margins of interest, while their ancestors were some of the most influential of their times. The southern Southwest presents a very different array of cultural manifestations than to the north, and this is at no time more pronounced than during the late prehistoric to historic transition. This difference is important if for no other reason than the unobtrusive character of evidence necessitates innovative methodological approaches and requires us to challenge existing theoretical constructs. Our ability to see, understand, and value these resources and the culture groups they represent is embedded in preconceptions that are only beginning to be unpacked. Long-held correlates and conceptual models of social processes and lifeways have prohibited understanding of this key period and limited our ability to understand the implications for organizational changes among historic groups that began in the late prehistoric period.

It was once the case that you would be cited as an authority on the so-called protohistoric (and early historic) period if you summarized early historic documents that characterized the local indigenous peoples at first contact or first sustained contact. Understandings were clearly focused on the historical encounter, largely because that was what we knew (because so little was available archaeologically), and because of the proclivity (and theoretical justification) of historical archaeologists to study themselves and other people in relation to themselves (e.g., Seymour 2013a, 2017a). The existing void in information was also interpreted as an absence of presence, with some researchers, even recently, suggesting that much of the southern Southwest was an empty landscape (empty niche) until right before Jesuit Padre Eusebio Kino arrived in the 1680s/1690s (e.g., see discussions in Seymour 2011a; Harlan and Seymour 2017). This resulted from the age-old problem of focusing on the trajectory of the more visible prehistoric groups, such as the Western Puebloans, whose presence in the southern valleys temporarily swelled and then dwindled and withdrew by the mid-1400s (see discussions in Harlan and Seymour 2017; Seymour 2017a). Other researchers, such as Doug Craig (2017) accurately note that the perceived void is simply a shifting of the Hohokam to less favorable drainages by the mid-fifteenth century, something I have suggested corresponds temporally with the dominance of a new group, the Sobaipuri O'odham,[1] entering the area and taking by force the best locations along canals, as conquerors tend to do (Harlan and Seymour 2017; Seymour 2014). Evidence of warfare and a new battlefield signature provide evidence that this transition was not entirely peaceful, although as I have discussed elsewhere, the circumstances varied across the region and the relationship was complex with these new groups living alongside existing communities for at least a century (Seymour 2011a, 2014, 2015a).

Clearly, an absence of recognized evidence is not evidence of absence and the perception of a void in people and information has diminished as publications rich with new evidence gradually penetrate the discipline (too numerous to cite here, but can be downloaded at https://independent.academia.edu/DeniSeymour).[2] Those who have immersed themselves in the abundant literature will note that the period has been substantially reoriented, recharacterized, and reframed over the last three decades. These revisions relate to an

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abundance of new chronometric dates, new surveys and excavations, new perspective on material cultural assemblages and their relationships to historically referenced peoples, collaborative work with descendant populations that incorporate and interweave traditional evidence, ethnohistory, and archaeology, and changing views on culture history. The topics of relevance, the methods required, and the applicable theory, even the starting point for discussion, have been fundamentally altered, as have been discussed at length in the source alluded to above. All this evidence essentially erases the protohistoric as a distinct period because the physical evidence, in association with chronometric dates, extends back into the late prehistoric period. The perceived occupational hiatus at AD 1450 is a concept that no longer serves (Seymour 2012a, 2012b). An abundance of new data from very early in time with a continuity in constellations of material culture now bridges this apparent divide. The continuum is of a different sort than many discussed earlier (Ezell 1963; Gladwin et al. 1937:18; Haury 1945:212, 1976:355, 357; Schroeder 1954:599; Weaver et al. 1978:78). Rather than seeing a gradual change from existing prehistoric cultures to those encountered historically, we see new patterns appearing in the late prehistoric period, contemporaneous with the existing ones, that continually transform as the historical divide approaches, as it is crossed, and then as it is left behind (Seymour 2011a; also see Masse 1981:47).

This continuum of occupation that bridges time also fills in the geographic space once thought devoid of people (Clark and Lyons 2003; Clark et al. 2004; Haury 1975, 1985). The presumed empty quarter actually contained what was a vast web of overlapping and entangled territorial movements and boundary claims of mobile people and the settled people whom they lived around. These cultural manifestations are becoming ever more vivid with the removal of the colonialist bent that championed an empty wilderness that was available for the taking. So much more remains to be learned, but with new ways of framing the question(s) we now have a hope of obtaining answers that are more successfully aligned with the fuller suite of data now available.

LONG-INVISIBLE AND UNDER-STUDIED PEOPLES

According to early historical texts there were several groups present at contact that have long been invisible to archaeologists. These documents provide a justification for the considerable effort that has been involved in searching for and characterizing these extremely difficult-to-define groups. Because of the hints of their presence and ways of life provided in the documents, many of these *naciones* have now been identified and distinguished in the archaeological record. These include numerous O'odham groups, including the Sobaipuri (who among the O'odham are the focus of this article), various Apachean groups (including the ancestral Chiricahua, who, again, are the focus of this article), and other mobile peoples (Jocome, Jano, Suma, Manso) (Figure 1). These have been or are in the process of being defined archaeologically as culture groups distinctive from one another and from the preceding and contemporaneous grand culture groups (e.g., Hohokam, Mogollon, Puebloan, Trincheras) of the American Southwest.

All of these terminal prehistoric groups have been chronometrically dated now to AD 1300, perhaps even the late 1200s, as some dating results of the hundreds of samples run suggest. This is three to four centuries earlier than previously thought. This evidence is specifically for the Sobaipuri O'odham, for the Chiricahua and Mescalero Apache, and for the Jocome. Even though many other groups were also present, these are the groups I have researched and for which abundant new data are available.[3] These early presence assertions are based on exceptionally good chronometric dates, including radiocarbon samples derived from annual plants (such as leaves and branches), directly from features inferred by a variety of means to be of these specific culture groups, and luminescence dates on culturally distinctive pottery and burned rock features. These samples have been obtained from exceptionally good contexts; only those samples that are in direct association with or are from distinctive material culture related to the group in question have been sampled. Hundreds of samples have been carefully collected and run over a 30-year period (Seymour 2002, 2011a, 2011b, 2012a, 2012c, 2013b, 2016a). The resulting inferences are that each of these groups was present in southern Arizona in this early period, the late prehistoric, and their presence bridges the terminal prehistoric into the historic period.

So much more has been learned about these historically referenced groups now that archaeology has been added as a source of abundant and reliable data to the existing suite of evidence. The relevance and applicability of existing forms of evidence also continues to grow as new interpretations and insights are brought to bear on long available and newly translated historical maps and texts (see for example, Seymour and Rodriguez 2020). Traditional stories committed to paper throughout time enhance interpretations, as do oral histories gathered from elders today that are added to the mix as they are critically assessed. Contradictions in the evidence are investigated with equal rigor to

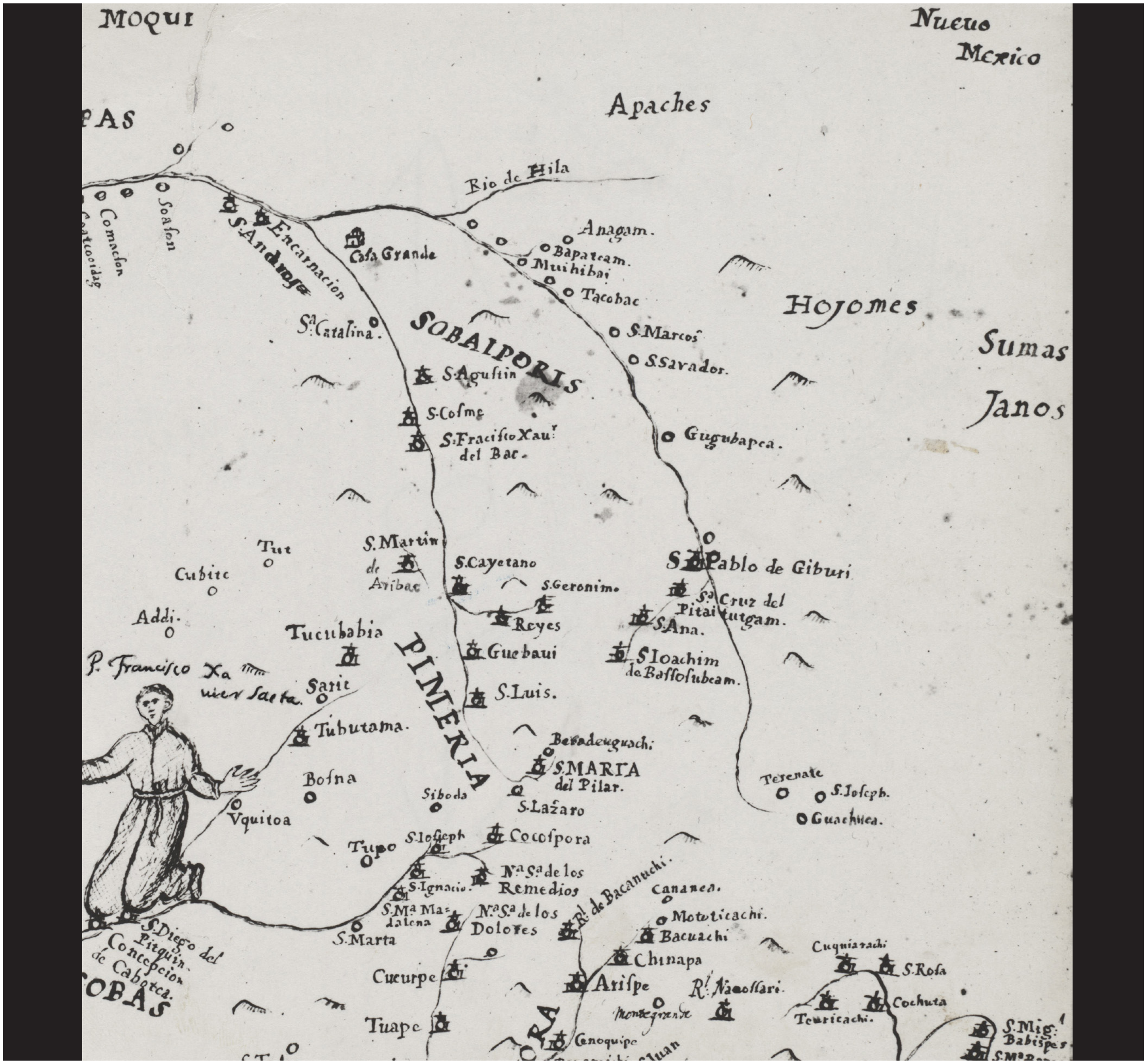

Figure 1: Detail of map drawn by Father Eusebio Kino in 1696--1697 showing the territories of the Sobaipuri O'odham, Apache, Jocome, and others (Burrus 1971).

those evidentiary sources that align. This article may be viewed as an update summary of my research to help characterize this period, a guide for scholars to the most recent inferences, conclusions, and the data that have been brought to bear to support and verify these inferences, as well as a hint of the types of methodological considerations that have guided this research.

Sobaipuri O'odham: A Sedentary River People

The Sobaipuri O'odham were the dominant group in southeastern Arizona in the terminal prehistoric period, yet they remain under-studied, at least comparatively so. Interviews with O'odham elders at Wa:k (historically known as San Xavier del Bac and where most of the Sobaipuri ended up) and consideration of the ethnographic literature indicate that the dominant clan of the Sobaipuri, at least at Wa:k, was the Buzzard Clan, with Coyote and other clans marrying in. Clans have lost their importance among the O'odham, and only some recognize their affiliation today, but prehistorically this social mechanism seems to have been more important for organizing society at large and within individual communities (see Seymour 2011a). Clan symbols, with clan colors, were once carried on staffs during ceremonies and other important events (Seymour, video interviews from Wa:k, 2007-2020). Clans are one element of the past that the Sobaipuri have in common with the Hopi and that may represent a shared heritage or influence of another kind (see Teague 1993).

Many current residents of Wa:k descend from the Sobaipuri. This is true even though three newspaper articles from the 1930s announced that the last of the Sobaipuris died out with the passing of Toribio Aragon and Encarnacion Mamake (Silver Belt 1931; Tucson Citizen 1930, 1931; also see Hoover 1935). Even ethnographer Ruth Underhill testified that the Sobaipuri had died out and this has been repeated in land claims documents and scholarly accounts since then (Hackenberg 1974; Underhill 1938:16). Yet, the Sobaipuri lineage is clearly not extinct, which prompts us to address the prevailing notions of tribal identity and heritage affiliation when reconstructing the history of a colonized people, especially when the goal was once their extermination or complete disruption of lifeways.

Many later travelers and settlers referenced these people as "Papago"—an O'odham group with a different lifeway and geographic presence than the Sobaipuri—despite a considerable continued presence of Sobaipuri there. These accounts raise the methodological issues as to the use of accounts by untrained observers, headstrong explorers, and self-interested developers and politicians for ascertaining identity and affiliation. While these labels and the associated lifeway inferences have persisted in the modern literature, archaeological data allow us to investigate the myriad of reasons why outsiders might refer to a varied people as a homogeneous lot or these consummate River People (see below) as transhumant. In this case, one part of the explanation very likely relates to the reality that if all riverside O'odham were considered mobile, then, by Spanish, Mexican, and American laws, their lands and water could be taken because these zones were wilderness, unoccupied, and undeveloped.

At Wa:k there are people who still recognize their Sobaipuri heritage, including those who are direct descendants of the so-called last of the Sobaipuri. My O'odham associates (David Tenario and Tony Burrell) and I have reconstructed family trees which demonstrate descendancy from these two key figures that were called out in the newspapers as Sobaipuri. For example, the Preston family represents descendants from grandchildren down to the great-great-great grandchildren of Toribio Aragon, many of whom are prominent members of the Wa:k community today. Moreover, two of the chiefs or headmen recorded historically as Sobaipuri carried the name Rios. Both Ascencion Rios and Charlie or Carlos Rios were captured in photographs and identified specifically as Sobaipuri chiefs in the late 1800s (1872, ca. 1895, ca. 1907; McIntyre 2008; Arizona History Museum Photographic Archives 1895). There is a direct connection between these headmen and modern residents of the Rios family, including Vice Chairman Jerry Carlyle. Carlos Rios had been referenced as the "last Sobaipuri chief" which has been interpreted to mean that he represented the last of the extinct Sobaipuri who was a chief (McIntyre 2008), but rather, he was the last "chief," not the last Sobaipuri and not the end of this lineage. Thereafter a new form of government was imposed and leaders were no longer referenced as "chief" but rather by other names, such as headmen, chairmen, and so on. Thus, Carlos Rios was not the last Sobaipuri nor the last headman but was the last chief who also happened to self-identify as Sobaipuri.

Wa:k's headmen have been highly influential through the ages. When Lt. Cristóbal Martín Bernal visited the village in 1697 he commented that, "At this very large ranchería, the largest which Pimería has…the governor is called Eusebio, an old man, a good administrator and well liked. In the rest of the rancherías they obey him promptly" (Smith et al. 1966:45). Wa:k's headmen had widespread influence then and continue to do so today. Evidence suggests that the Sobaipuri had a ranked society with persistent leaders, perhaps even hereditary. There were village leaders and also a headman who had some authority over multiple villages owing to his leadership skills and respect. Leaders would coordinate canal cleanings and maintenance, arbitrate disputes, decide on land distribution, interface with outsiders, and a host of other responsibilities.

In the mission period Wa:k was the largest settlement in the region (O'odham and otherwise). In 1692 during his first visit to the village, Kino commented: "I found the natives very affable and friendly, and particularly so in the principal ranchería of San Xavier del Bac, which contains more than eight hundred souls" (Bolton 1948:I:122). A year earlier he has been greeted by emissaries from Wa:k who had asked him to come north and tell them about himself and what he was bringing. A few years later (1697), Kino reported that at Wa:k "…and its environs we saw and counted more than six thousand people" (Bolton 1948:I:173). Wa:k and the surrounding area was the center of the Sobaipuri world, at least in the mission period.

The Sobaipuri occupied large planned villages with formal layouts (Figure 2). The houses were not widely dispersed, as they were among people further west and northwest. They were not diffuse rancherias, as they were among the Tohono O'odham. Sites exhibit a consistent uniquely Sobaipuri plan, that was unlike the earlier Hohokam and not like the nineteenth and twentieth century ethnographic period O'odham. These arrangements were formed by paired houses that represented the household unit. Houses were covered with mud that masked the reed mats and branches that formed the superstructure (Seymour 2011a).

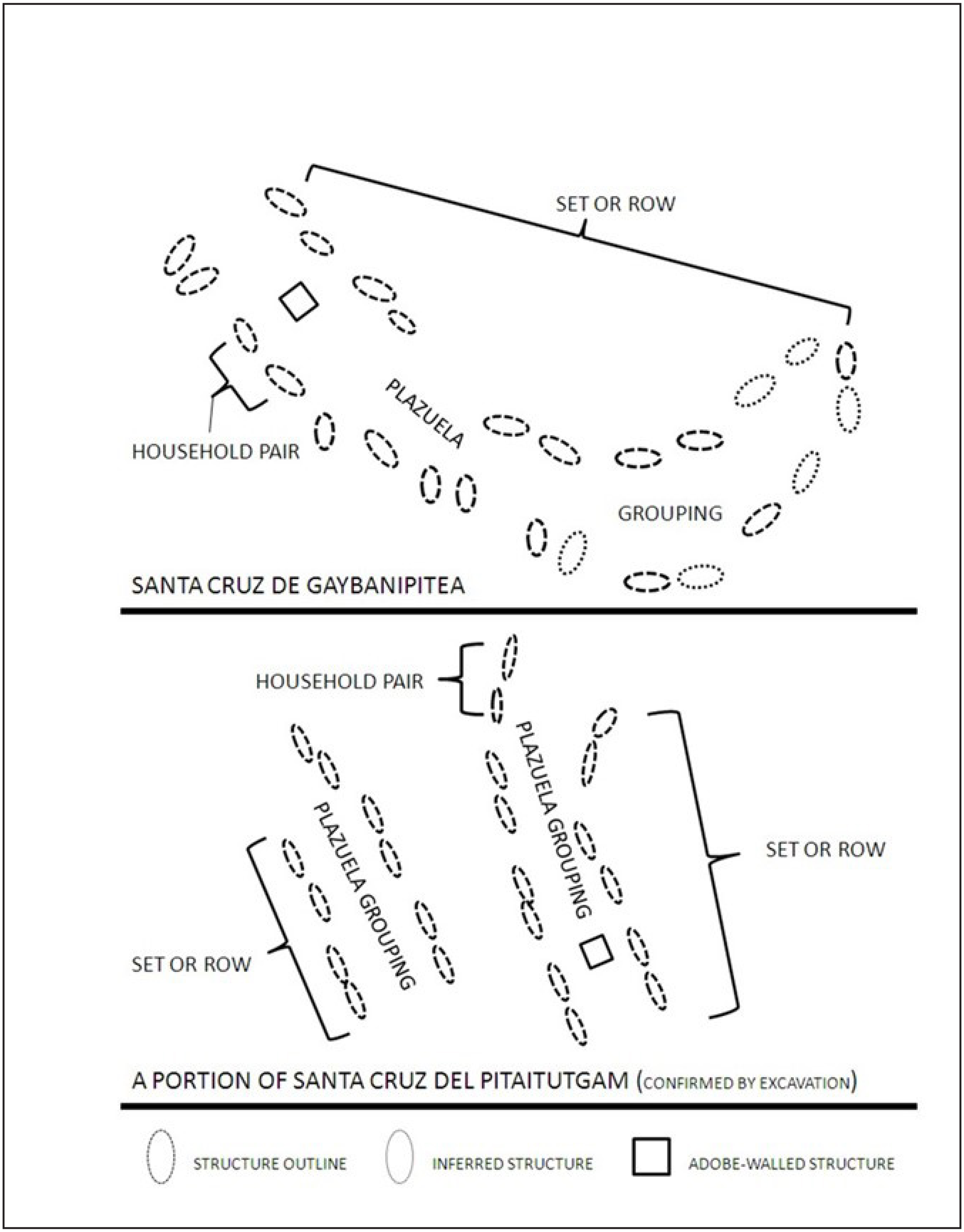

Figure 2: Layout of Sobaipuri villages; from Seymour (2011a).

The Sobaipuri O'odham were archetypical River People or Akimel O'odham. They relied on irrigation agriculture, and unlike their two-village neighbors to the west (Tohono O'odham) and northwest (Kohatk), and mobile kin (Hia C'ed) to the far west, their villages were permanent. Each village was occupied year-round, although their locations shifted every 20 or 30 years. Their villages moved up and down a river segment but maintained a presence where the reliable surface water could be found and where they could continue to utilize their investments in canals and fields. I have recorded three canal systems that seem to have been constructed and used by the Sobaipuri (at Guevavi, Santa Cruz de Gaybanipitea, and Quiburi of Kino's time; Seymour 2011a, 2014). Other old canals are present in the fields north of present day Wa:k, around Tucson, and near San Jose de Tumacácori, some of which relate to Sobaipuri usage.

This Sobaipuri settlement pattern has baffled scholars for decades because evidence is so unobtrusive, yet these people were so important to history and hosted so many visiting historical giants. Consequently, historians have expected substantial adobe house walls, colorful decorated pottery, and definitive walls defining monumental churches (Seymour 1989). Yet the Sobaipuri pattern of house construction (in materials used and archaeological signature left) is much more similar to mobile groups than to Puebloan groups to the north and east. While the Sobaipuri were permanent occupants of the river margins, their settlements do not show the accumulation of debris found in Puebloan, Mogollon, or even Hohokam sites. This is because they dumped much of their trash over the terrace margins, artifacts have eroded down slope, and also because they used many more perishable materials and plainware pottery that was fired at lower temperatures. Consequently, their material culture signature is once again more closely aligned with the pattern thought most typical of mobile groups than to the more substantial and robust patterns found to the north. Another reason for their lighter footprint is because they moved up and down the river margin, uprooting their village every 20 or 30 years. This latter custom means that there are many sites strung along the river that represent a single population as it moved through time. This resulted in lighter imprints than many comparatively sedentary communities to the north owing to the relative shortness of stay.

This cultural pattern of village drift (e.g., Ezell 1961) has important consequences for indices relating to settlement permanency and settlement system reconstruction. Generational village shifting increased site frequencies and therefore makes population levels appear to be much higher than they were. Aggregation into fewer and larger settlements over a short period of time has created the illusion of a settlement pattern characterized by a central place. Some instances of reoccupation of the same ridge, but in a slightly different location, make small settlements look large; the occupational complexity (without much stratigraphic differentiation) conveys a settlement system much more organizationally complex than perhaps it was. Historical documents provide hints of the same populations shifting and fine-grained dating techniques parse discrete occupational events, providing a counter narrative in an interpretive framework wherein faint tends to equate to simple, intermittent, and short term. These villages were referenced as *rancherias*, illustrating the incongruence between historical descriptions and current anthropological classifications, wherein by population size and site layout many of these places qualify as villages, at least in scholarly discourse and anthropological classification schemes. Accepted disciplinary indices of settlement contemporaneity, population levels, and settlement systems are inappropriate for these people.

Because the Sobaipuri dominated the rivers and had to protect their claim to the land and its productive bounty, they became the best and most feared warriors. Even the Apache feared them in the late seventeenth and early eighteenth centuries (see Seymour 2014). They had an established and widely respected warrior force, and because they lived along the rivers, which were also travel and trade routes, they were also recognized as diplomats and traders. In fact, their prowess as warriors earned them the O'odham name by which we call them today, which means "of" or "like the enemy."

It should be clear by now that O'odham residence and history does not begin with Kino. Inaccurately, many people suggest that Tucson was founded in 1692 because this is when Kino first visited Wa:k and presumably Tucson (Bolton 1948:122-123). While Kino was an important figure in O'odham history, and he placed the Sobaipuri and Wa:k on the map, literally, their history and presence is much deeper. Archaeological investigations demonstrate an emergence or appearance of the O'odham signature in the archaeological record in the late 1200s, certainly by AD 1300 (Seymour 2011b, 2014). Thus, there is clearly a period of overlap between the prehistoric Hohokam and the Sobaipuri O'odham. Obvious differences are visible in the archaeological records of the Sobaipuri O'odham and other prehistoric groups who occupied these rivers, including in site layout, as suggested above, and in house plans, pottery, and projectile point styles (Figures 3-4).

The late Wa:k elder Edmund Garcia commented that the O'odham "chased the Hohokam out," which is a position also stated in some of the O'odham creation stories in early ethnographies (2007 personal communication to Deni Seymour; Russell 1975; Underhill 1939).

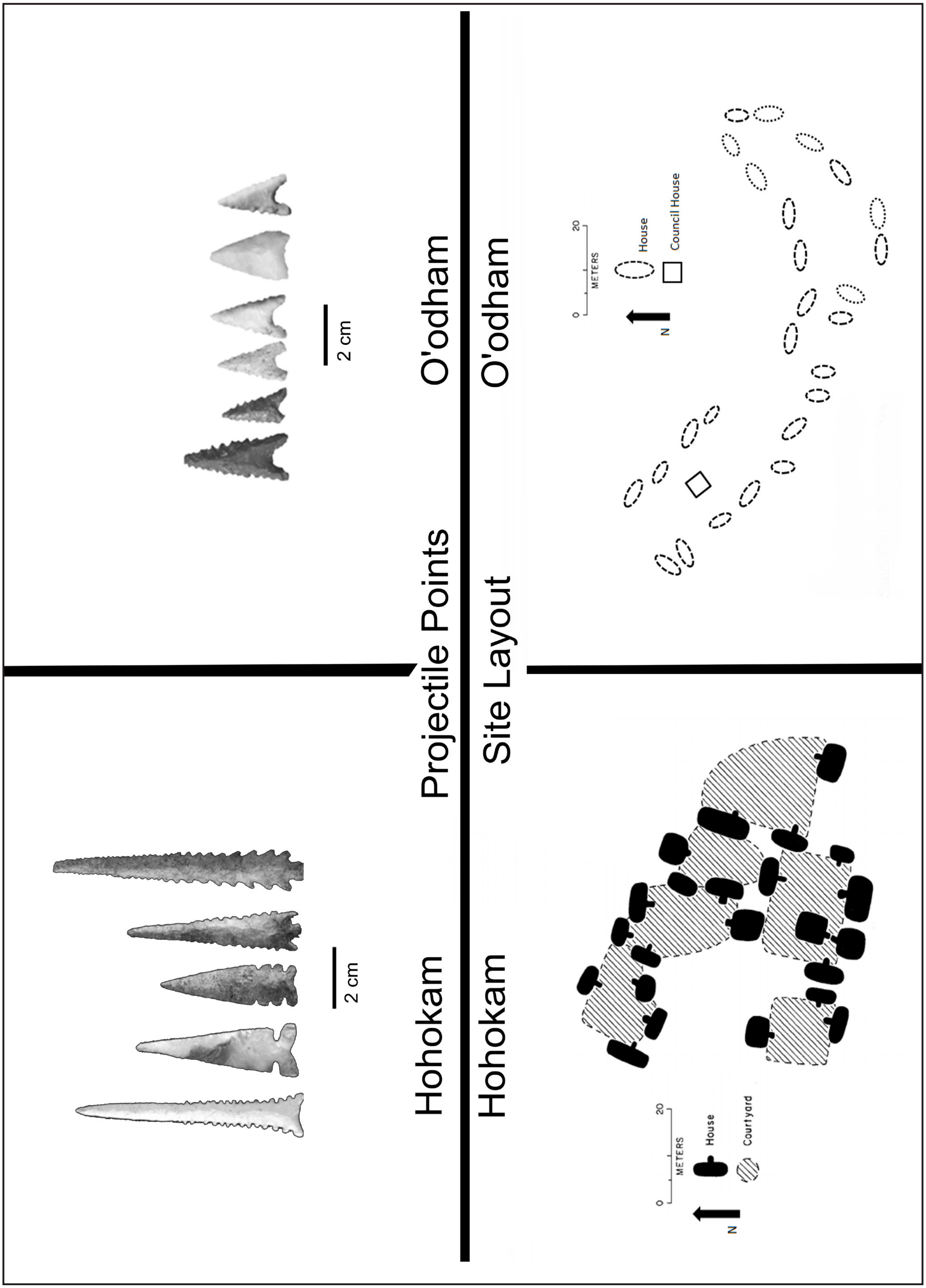

Figure 3: Differences between Hohokam and Sobaipuri (a) arrow heads and (b) site layout.

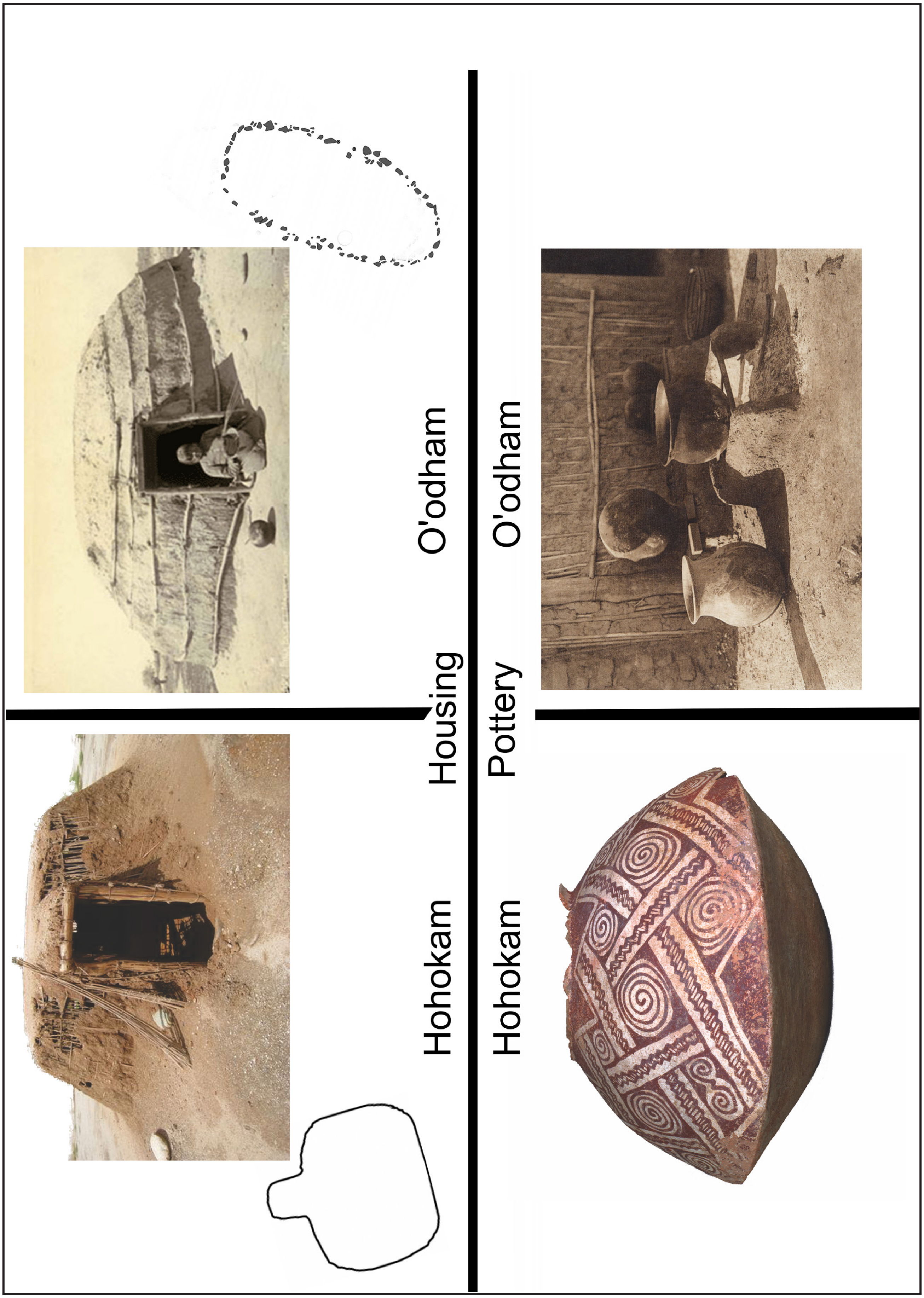

Figure 4. Differences between Hohokam and Sobaipuri (a) house plan and (b) pottery.

This is borne out in archaeological evidence, both in the early dominance of the Hohokam and other groups on the San Pedro and the initial advance southward of the Western Puebloan groups, on the one hand, and the northward movement of Sobaipuri village sites beginning perhaps in the late AD 1200s commensurate with the withdrawal of existing populations (see more extensive discussion in Harlan and Seymour 2017). The earliest chronometrically dated Sobaipuri sites occur to the south near the Fairbank area while those from further north, up to near the Gila confluence on the San Pedro River, are so far later indicating perhaps a gradual movement to the north as prehistoric groups moved out (Harlan and Seymour 2017).[4] Many of the late prehistoric sites along the San Pedro that were occupied to about AD 1400 exhibit evidence of warfare or perhaps conquest including many directly on the river and many along tributary washes and in adjacent valleys (e.g., many unnamed and also better known sites such as Garden Canyon, Babocomari, Kuykendall, Buena Vista, etc.). This newer evidence seems to support the traditional stories told by some O'odham and as stated by Garcia (see Seymour 2011a). Importantly, however, the transition likely occurred differently throughout the region, with localized consequences.

This glimpse into the substantial difference between what has sometimes been said and what is now being reconstructed demonstrates that these were impactful and unconventional peoples that have remained for too long at the margins of interest. Their ancestors were some of the most influential of their times. Regrettably, they are often overshadowed by the historical giants, such as Kino, and the dominance of prehistoric cultures, such as the Hohokam.

Mobile Peoples

Along with the Apache, a series of lesser-known mobile groups appear at the margins of some of the region's earliest maps, those of Father Kino. These groups were mostly enemies to Europeans and they inhabited the hinterlands where Spaniards only ventured on campaigns and, thus, they occupied the edges of the Spanish knowledge (see Figure 1). Of those I study, the Jocome and ancestral Chiricahua Apache are most relevant to southeastern Arizona although many more whose homelands were elsewhere were commonly recorded as being present throughout this region. The Late Prehistoric and Colonial periods were tumultuous times, characterized by periodic movement of people over vast geographic areas; this fact of diffusely defined territorial boundaries makes their definition in the archaeological record challenging (Seymour 2016b). Consequently, we know less about the Jocome and ancestral Chiricahua Apache than many contemporaneous groups in this region. Other reasons for this and many of the impediments to further study will be discussed after a brief introduction into what is now known about their archaeological and historical character from recent research. Each of these two groups is necessarily treated briefly to leave room to discuss some important methodological and conceptual issues related to their recognition and verification.

The Mobile Jocome

One of the more important mobile groups was known as the Jocome, whose archaeological signature has been defined as the part of Canutillo complex (Seymour 2002, 2009a, 2011a, 2014, 2016a; Seymour and Church 2007). The Canutillo complex has been defined more broadly and as a constellation of archaeological traits likely represents both the Jano and Jocome, although further refinements are expected as research continues (see Seymour 2009a, 2014, 2016a). The Canutillo complex is represented by improvised oval surface structures, expedient ground stone, hide working stones, and a formal or curated flaked-stone assemblage of distinctive knives, scrapers, small somewhat triangular basally notched points, and perforators made using a technological organization most similar to that of the Archaic period. In fact, as will be discussed below, their tools and knapping debris have been mistaken as Archaic in many circumstances, including at Ventana and Pendejo caves (see discussion in Seymour 2009a, 2014; Seymour and Church 2007). Their artifacts are commonly found overlying Sobaipuri sites and as such were for years thought to be the defining criteria for the Sobaipuri, as will also be discussed shortly. Archaeologically this complex occurs throughout southeastern Arizona and southwestern New Mexico, and presumably in northern Sonora and Chihuahua. This complex is found throughout the area shown on seventeenth century maps as occupied by the Jocome and Jano, but also overlaps with the culture areas assigned to others, including the Sobaipuri, Apache, and Jano. Territories were not exclusive; many groups used the same areas or different niches in the same zones, and mobile people hunted, raided, traded and settled in areas used and claimed by others (Seymour 2002, 2012a, 2012c, 2016b, 2017a). Both the Jocome and ancestral Chiricahua Apache occupied the mountains as well as intervening river valleys, using those portions of the valleys that were not dominated by the Sobaipuri.

Chronometric dates (mostly luminescence dates on pottery and burned rock) and cross-dating with raided and traded ceramics indicate a presence for the Jocome beginning in the late AD 1200s, as with all the other groups discussed in this article. Their observable presence ends with the gradual merging of the Jocome and Jano with neighboring tribes, although people still recognize their heritage today as originating with these historical groups. Of course, the use of cross-dating implies that pottery was seized in raids, as well as obtained via trade and as gifts, as I have discussed previously (Seymour 2008a, 2008b, 2011a, 2016a). This issue of ceramics obtained through raiding is discussed more thoroughly below since it is a contentious one and requires explanation and adoption of new conceptions that stem from a refined reading of the historical and archaeological records.

Less is known about the Jocome from a historical standpoint than many other groups, which is one reason why it has taken so long to identify them in the archaeological record. Some time ago, it was thought that they were simply Apachean (Forbes 1957, 1959, 1960), but instead their language was probably Uto-Aztecan and their material culture is considerably different and represents an entirely unique technological organization and a projectile point style distinct from that of the Apache. Even when they began roaming, raiding, and allying in war with the Apache their material culture remained distinctive for some time (Seymour 2002, 2009a, 2016a; Seymour and Church 2007). Many of the mobile groups in the area were often mentioned together, such as the Jocome, Jano, Manso, and Suma, and often with the Apache or various Piman (O'odham) groups. The social advantages to the comparatively small distinct groups coming together included the ability to find mates, a wider network with which to trade, larger hunting parties for game that required cooperation, planning for certain types of raids that required a sizable number of men, and a strong alliance against enemies, including the Spaniards. The perceived advantages of inter-group alliances in warfare are apparent in the many references to such war parties in the documentary record and also in the 1698 attack on Santa Cruz de Gaybanipitea. There, under the leadership of the Jocome, around 500 allied forces from five different groups attacked the 80-person Sobaipuri village of Quiburi. Forces of this size were common at the time, with up to 700 warriors being reported (Seymour 2014, 2015a). Warfare and disease led to diminishing population sizes of many of these small distinct groups.

Perhaps the earliest reference to the Jocome in southern Arizona was in 1540 when Jaramillo, chronicler of the Coronado expedition, was greeted by a small group of mobile people who he referred to as "poor Indians." They offered "gifts of little value" as well as roasted maguey stalks (agave hearts) and pitahayas (saguaro) (Bolton 1991:297; Flint and Flint 2005:513; Seymour 2008c, 2009b, 2009c, 2016a). These are the types of resources expected for highly mobile people who lived in small family groups and who searched appropriate sectors of the landscape for edible plants and animals.

Some of the earliest documents that mention the Jocome by name in this area are legal in nature from the 1680s. The Jocome and Jano were mentioned together as having taken up residence in the Quiburi (middle San Pedro) Valley. They had adopted farming and had settled down on land given them by the Sobaipuri. Yet this friendly alliance was broken by the Spaniards, who were intent on maintaining the Sobaipuri within their fold (Castillo Betancourt 1686; Pacheco Zevallos 1868a-c). Little more is available in the documentary record about this settlement and alliance, but the probable area of this riverside settlement(s) (AZ EE:4:31(ASM), AZ EE:4:36(ASM), and AZ EE:4:181(ASM)) has been identified. They are unique among the many Sobaipuri sites recorded along this stretch and reinforce mounting evidence as to what Jocome sites look like. Data from these sites and others indicate that despite residing with and near other groups, these mobile settlers maintained many of their traditional ways for about a century more. This is evident in the continued construction of curvilinear surface structures, as is common for mobile people, and the manufacture of their finely crafted stone tools that were designed to be resharpened and used repeatedly. Even when settled near Quiburi, there were only a half dozen to a dozen houses, indicating a small social grouping. Small site size likely relates both to their characteristic life way and to the fact that probably only a subset of these people would have been interested in settling down. Historical documentation of their presence here at Quiburi, in the Gaybanipitea battle mentioned above, and in other locations help confirm their identity in the archaeological materials found.

Apachean Groups

The Cerro Rojo complex defines the ancestral Chiricahua and mountain-based Mescalero Apache (Seymour 2002, 2004, 2012a). It consists of a constellation of traits including a distinctive flaked-stone assemblage (that includes side-notched arrow points), circular to oblong surface structures, uniquely Apachean rock art, and occupation of distinctive sectors of the terrain in select portions of the landscape, as described and discussed exhaustively elsewhere.

Like the other groups in the region, the Apache seem to have been present beginning in the late AD 1200s (Seymour 2012d, 2013b). Their sites occur throughout a broad geographic area and literally thousands of sites have been recorded in the southern portion of the Southwest. I can now predict the location of Apache encampments, although their locations changed through time as a result of political interaction with neighbors (see Seymour 2012e). Apachean sites can also now be identified in the absence of European artifacts, so it is possible to detect those that precede European presence. This has made all the difference in extending their presence back in time because when relying on worked glass and metal to distinguish Apache sites there was no possibility of identifying anything that might occur prior to Europeans.

Our understanding of the types of sites expected has grown as archaeological data are correlated to the historical and ethnographic records. Local group basecamps were the most basic form of residence among both the Chiricahua and mountain Mescalero where multiple families lived together. While these sites varied widely in size, they usually were occupied by 10 or 40 families, as attested to by archaeological examples (including two in the Franklin Mountains [41EP396, 41EP401]). Land Claims documents indicate that each local group territory had at least two of these base camps, one for summer and another for winter (Henderson 1957).

From these home bases smaller family or task-based groups went out regularly for a week or more to procure food, to raid, and to visit. These small groups often traveled to a known destination. They might go to a caching location, such as the 30-acre Hormiguero site in the Peloncillo Mountains (AZ CC:12:58(ASM); Seymour 2013b), or a favored piñon collecting or mescal processing location, such as the Three Sisters site in the Dragoon Mountains (AR 03-05-01-442; Seymour 2017b). Temporary encampments established along the way might consist of a hastily constructed shelter or something quite insubstantial, such as a clearing padded with grass in the boulders, in a rock shelter, or under a tree. Many insubstantial hut rings in the Whitlock Mountains (AZ CC:7:11[BLM]) may represent locations where a single family or task group camped briefly near water while in route.

Ethnographic and historical sources indicate that much larger residential groupings were formed when there was a desire for a social or ceremonial gathering or need for a large defensive force, an organized raid, or hunting party (Ball 1970:22; Basehart 1960:60-61, 110; Betzinez and Nye 1959:85; Cortés y de Olarte 1989:65; Matson and Schroeder 1957:342; Seymour 2004, 2008b; Sweeney 1991, 1992; Robert Geronimo in Henderson 1957:414). Multiple groups, usually bands, came together routinely at these extra-large residential sites, such as the 130-acre, 200-plus-structure Cerro Rojo site (LA 37188) (Seymour 2002, 2004, 2008b, 2009d).

The Apache have remained invisible for so long because the evidence considered diagnostic for those Apachean groups in the northern Southwest have been applied inappropriately to those in the south. I have proposed revising the Apachean ceramic classification scheme (Baugh and Eddy 1987; Seymour 2008a) to take into account that Apache pottery in the southern Southwest is brown ware, owing to the fact that the clay is brown, as opposed to northern gray ware ceramics that formed the basis for Baugh and Eddy's initial classification. Under my proposed classification, Peloncillo Brown Ware, relevant to the Chiricahua and Mescalero, is equivalent to Quemado Gray Ware, under which a Navajo series and a Jicarilla series are classified (see Baugh and Eddy 1987). This revised classification recognizes that Apache pottery was not similar throughout the entire Southwest or across Apachean groups. Greater understanding of the range of variability (vessel form, finishing techniques, and clay and paste characteristics) of Apachean and non-Apachean pottery demonstrates that many of the vessels previously thought to be Apachean are actually representative of non-Apachean groups (for example several of those pictured in Ferg 2004 are not Apachean; see Seymour 2008a:170, 179).

Brown ware Apachean pottery has been found in many contexts. Yet, we still do not know how early the Apache adopted ceramics or if they brought the technology with them. The earliest dates on pottery inferred to be Apachean are in the AD 1400s (see Seymour 2002, 2003, 2004, 2008a, 2012a). Each Apachean group seems to have developed pottery that is like that used by their neighbors, both in clay color (brown wares in the south) and surface treatment. The similarity may be because pottery was not especially important and so they did not develop their own pottery tradition, or because they kidnapped or married women from neighboring tribes who transmitted the technology. Clearly, some of the pottery was raided or traded, further complicating the picture (Seymour 2008a; also see discussion below). A telling example that pottery may be an index of cultural interaction rather than a direct indicator of cultural identity is provided by a Tonto Apache woman who noted "these [pots] are not ours" with regard to a series of pots situated around her house, and then she continued by describing from which neighboring groups she had obtained the vessels (Goodwin 1929-1939). This leads us to the need for a short discussion regarding a host of issues that have made identifying the mobile peoples of this area difficult, including the pots of other people.

Recognizing Unobtrusive Sites and Components

Clearly, the Apache and Jocome left a light archaeological footprint that until recently rendered them indistinguishable if not invisible to most archaeologists.

Consequently, these groups have been mostly known from the ethnographic and historical literature. For the Apache, this has meant that information has been slanted toward later Apachean adaptations, after substantial changes had occurred within their society, but has nonetheless incorporated assumptions (often unexamined) of continuity through time. Learning to see and distinguish the earlier evidence has been central to defining the non-sedentary groups in the southern Southwest (Seymour 2012a, 2012d). For late hunter-gatherer-raiders whose signatures are light, ascertaining age and affination has been challenging, while for better-known groups (such as Puebloan, Hohokam, and Mogollon) assigning site cultural affiliation has been seen as relatively straight forward.

First among the reasons for difficulty in seeing and recognizing these sites and components, in this case for the Jocome, is that the signature had been mistaken for that of the Sobaipuri and the Archaic. This has occurred both because so many Jocome (and Apache) sites overlie or are intermixed with the Sobaipuri (or prehistoric evidence) and because the tools and debris are quite similar to the curated technological organization of the Archaic owing to a mutual mobile lifestyle (see Seymour 2002, 2014, 2017a, 2017b; Seymour and Church 2007). It was once thought that the Sobaipuri were mobile, both because of the analogy to the Tohono O'odham (aka Papago, rather than the understanding their river adaptation) and owing to their light archaeological signature. Jocome and Apache material culture often overlaid Sobaipuri sites which also contributed to this misimpression. In fact, for decades Jocome tools were thought to be indicative or diagnostic of Sobaipuri material culture. Early original work defined the Sobaipuri O'odham on the basis of stone tools that we now know are representative of the Jocome. One example is a burial in Tucson (Brew and Huckell 1987) but also residential sites had been identified mostly on the basis of these distinctive Jocome stone tools when found with characteristic Sobaipuri house outlines. These village sites with the unique Sobaipuri house outline often co-occurred with an intermixture of Canutillo complex materials, as occurred at Second Canyon and elsewhere (Doyel 1977; Franklin 1980; Masse 1981).

A more recent example is from an abandoned Sobaipuri village (AZ EE:6:106[ASM]) on Sonoita Creek that was overlain with Canutillo complex tools situated around a distinctive Sobaipuri house outline and adjacent to its entryway. Such a direct spatial association is a common basis for inferring that artifacts and features on the same surface are culturally and temporally related. Yet, these mobile hunter-gatherer-raiders (Jocome) who roamed the landscape contemporaneous with the Sobaipuri sometimes utilized deserted structures and discarded debris left exposed on the surface before the features and cultural layers were buried (Seymour 2010a). This also occurred at the San Pedro sites cited above and at another site (AZ EE:9:153[ASM]) near the mouth of the Santa Cruz River and Sonoita Creek where Canutillo complex materials (including a whetstone and formal tools that were found inside and immediately around the structure). Because a sufficient number of these Canutillo complex sites have been defined and confirmed as affiliated with a distinct culture group it is now possible to distinguish these as an additional component. The short timespan between initial Sobaipuri abandonment and later Jocome reuse provides an important laboratory for differentiating sequential use when stratigraphy is lacking on multiple component sites. The ability to distinguish distinct components is critical during this late period when most sites show evidence of many different uses with little if any sediment accumulation between uses (Seymour 2010a, 2017a).

In other instances, rather than seeing but mistaking the Jocome or Apache evidence for something else, the mobile group component is simply not seen owing to the abundance of accumulated material culture from other groups. Their light signature is sometimes overshadowed or eclipsed by the more robust evidence of earlier and later occupations and by the dominant and long-understood signatures we recognize, as the examples just presented and others illustrate (Seymour 2010a, 2017c). This has been a factor for Sobaipuri component recognition as well and contributed for decades to the inability to identify the original Sobaipuri settlement of San Cosme de Chuk Shon, Tucson's birthplace and namesake. Until its recent discovery, this component had been obscured by the dominant Trincheras culture material. In our categorization efforts as archaeologists we are drawn to what we recognize. Consequently, one dominant pattern or one shiny bauble, one clearly identifiable item introduced as a result of a raiding expedition or earlier occupation, one projectile point or decorated potsherd, outshines the more mundane aspects of the assemblage, focuses vision, and renders all else virtually invisible or, at a minimum, provides a measure of familiarity and thus relief from uncertainty. This accounts for the common practice of searching the surface of an unfamiliar site, only to find a single painted sherd, and then, on the basis of that single item, pronouncing on site age and cultural affiliation. Yet, not only are "protohistoric" components often found as one of many distinct occupations, but artifacts from other groups are often associated and intermixed with that "protohistoric" component.

The problems presented by an especially light archaeological footprint and either co-residence or sequential residence by more than one group are compounded by assemblages that often present mixed signals regarding cultural affiliation. For raiders, in particular, evidence of certain types of interaction between groups is expected that brings artifacts from other groups into their encampments, as spoils from raiding or as trade items. In fact, the association of material culture from other groups is one way to substantiate the presence of mobile raiders. It is an index, if you will, of raiding and trading, *a cultural interaction index*, rather than a direct indication of cultural affiliation (Seymour 2014:195; 2017d:59). Because raiding was such an important part of many mobile groups' adaptation in this region, this process—raiding that brought foreign objects into encampments—is elevated in explanatory and interpretive importance over its role among many better-known culture groups. Raiding and trading are key aspects of mobile group behavior which means that we should expect the material culture of other groups on mobile raider's sites that are an indication of interaction in various forms. Similarly, scavenging and the incorporation of others' material culture into their own are characteristic of Jocome, Apachean, and other mobile groups. Far from being the exception, the material culture of others should be anticipated on raider's sites and on sites of mobile groups who move around and interact with others from broad-reaching areas. Foreign or non-local items are often found on sites of sedentary farmers but these items, often obtained through trade, tend not to overshadow the abundant assemblages that represent the resident group, as they do on mobile sites.

When certain items are recognized as being indicative of inter-group interaction, their value for identity construction becomes apparent. Pottery can both be an index of cultural identity and of cultural interaction. Certainly, in some instances, diagnostic decorated pottery can be a direct indication of site affiliation, such that the presence of Zuni or Hopi pottery may indicate the presence of Zuni or Hopi residents. In this instance, the nature of other artifacts, structures, and landscape use will all provide hints as to the cultural origin of the residential site. Fortunately, mobile group sites and their constituent parts look very different than special-use sites for more sedentary people. This is because of the different ways mobile groups use the landscape and create features than more sedentary people do, even on their limited-use sites (see Seymour 2002, 2004, 2008b, 2009b, 2009d, 2010a, 2010b, 2013c, 2015b, 2017a, 2017d). But pottery present on mobile group sites is often not a straightforward index of cultural identity, though it is often treated as if it is. Interaction between groups is expected on a variety of levels and some aspects of this interaction may be encapsulated in artifacts encountered at a site. Consequently, quite often Zuni or Hopi pottery may be an indication of other groups whose lifeways revolved around raiding (taking other people's stuff), as is evident in many sites on the lower and middle San Pedro River. Foreign pottery in such instances is an index of raiding (or trading) and thereby evidence of mobile raiders, not the group whose stolen (or traded) pottery is represented (see Seymour 2014 for a discussion). Low frequencies of spoils from raiding or trading may be the only traditionally diagnostic items on a site, but this does not mean they are directly indicative of cultural affiliation of the site (although they are often treated that way). Rather, they may be indicative of raiding behavior, which in itself is indicative of the resident mobile group (and of the site) rather than an indication of the makers of the pottery.

This concept that the dominant diagnostic items (on a site with few materials) may indicate a group other than the one who made those items, requires a perceptual shift that is critical for differentiating mobile components on sites that were used for centuries by many different peoples. Acknowledgement of raiding as a dominant behavior in this period and recognizing the indices of raiding for what they are, rather than as a direct indicator of a site's cultural affiliation, can help with site or component interpretation. Clarity is provided by the researcher's analysis of the entire context of the site. Interpretation of the role of diagnostic items is clearest when coupled with other usually unobtrusive evidence of a mobile group presence, such as structures and distinctive flaked-stone tools and debris. Having confidence in the subtleness of these later signatures is the first step.

Failure to understand the prevalence and impact of raiding on assemblage composition, along with multiple components, has led to the invisibility of these components. The presence of many different vessel types and projectile points at the Cerro Rojo site is a prime example of the end result of this process and an illustration as to why the Apache and Canutillo complex components were missed for years. This site also shows how the presence of items from other groups can lead to misidentification or eclipsing of the "protohistoric" component if our interpretive skills remain focused on the most visible components and on the processes relevant largely to sedentary farmers (see for example, Seymour 2008b). Many other sites, including Jocome Hill (AZ BB:2:142[ASM]) in southeastern Arizona, also serve as examples of this form of obfuscation that is effectively alleviated by focusing on processes relevant to mobile raiders (Seymour 2016a).

Another reason the impact of raiding on the artifact composition of a site is usually missed is because of the misimpression that clay vessels were not raided. Because pottery is so visible and is one of the most commonly used indices of culture and time, it is usually placed front and center in analysis. The commonly held notion, based in part on LeBlanc's (1999) work about prehistoric warfare in the region (raiding of course being different than warfare), is that raiders did not transport pottery. Among the numerous objectives of raiding and warfare listed, seizing of pottery does not figure in any of them, according to LeBlanc. The widely held understanding is that because pottery was so fragile, it usually was not taken during raids; but rather, human captives, livestock, textiles, and other more transportable objects were commonly taken. Some suggest that pottery would more likely be destroyed in raids, which of course, had been reported occasionally for the Apache, but does not seem to have been common. Yet, there are several misconceptions entangled with this argument that pottery was not taken in raids, as I have explained previously and will reiterate here (Seymour 2011a).

The late nineteenth-century model that usually informs interpretations conceives of raids as fast and furious, hit-and-run events wherein fragile items would almost certainly be broken or found to be too unwieldy to transport. Yet, the earliest historical accounts in the region recorded by the Cabeza de Vaca and Espejo expeditions, as well as others, demonstrate that raiding was already widespread in the sixteenth century and took many forms, including villagers abandoning entire villages when under threat, leaving goods available for leisurely and selective taking by raiders (Hammond and Rey 1966:162). In other territories, villagers remained but piled goods in the center of their homes, turning their backs, allowing the looters to take all they desired with no resistance (Hodge and Lewis 1990:103). This allowed marauders to remove and carry away select bulky and breakable items, and in some recorded instances so much was taken that the villagers were left with little ("without leaving anything;" Hodge and Lewis 1990:91). Among those items taken were vessels filled with grain. Yet, thieves tend not to mention the containers in which their loot is carried, in this case, durable ceramic byproducts that transported items of value only to be reused or discarded but not viewed as particularly important. This conception that vessels were transported along with their contents of value is borne out by Cabeza de Vaca when he noted that "six hundred people came, bringing all the corn they had in pots sealed with clay, in which they had buried it to hide it" (Hodge and Lewis 1990:113-114; Cabeza de Vaca et al. 1993:109). These accounts and others demonstrate that our modern notions of raiding, based largely on late Apache behavior, are inappropriate models for earlier in time, in the pre-horse era, and are based on inapplicable assumptions that assume continuity from the late historic period back in time.

Archaeological data found on early raiders sites, such as those of the Jocome and Apache, indicate pottery was among the items taken. Even the mountain top Cerro Rojo and Jocome Hill sites discussed above and many of the mountain-based Apache sites around El Paso have revealed abundant evidence, relatively speaking, of vessels from riverside missions or from settled farming villagers. Raiding has been suggested as one explanation for Sobaipuri pottery being found at the riverside mobile group Canutillo complex settlement above Tubac (Sharples Site, Seymour 2009a, 2010a), and for Sobaipuri-looking pottery found on Apache sites in the Peloncillo Mountains, at the Kuykendall Ruin, at Whitlock Cienega, and elsewhere, far outside the normal Sobaipuri range. I have argued that it is more likely that a raiding group would bring a thin-walled and open-mouthed jar to the mountains or deep into their territory than it would have been for the O'odham to bring them there when baskets or gourds would have been more useful as water vessels when on journeys. Unless the Sobaipuri were making saguaro wine, living there, or participating in a limited range of other activities, all of which would leave tell-tale evidence, the presence of their pottery in these hinterland areas is likely indicative of the presence of mobile raiders. Travel on a trading expedition or hiding out from the missionaries during an uprising also come to mind as potential explanations, but these too should leave definitive clues that differentiate even these temporary sites from those used by mobile groups. Such an explanation has been suggested for the foothill Sobaipuri settlements near the Santa Rita Mountains (see Seymour 2011a). These examples reveal how archaeological data can be used to correct assumptions of continuity of practice though time, including those regarding raiding, that are based on inappropriate historical analogs (Seymour 2002). Yet more commonly researchers adhere unwaveringly to this assumption that raiders did not take pottery vessels. This predisposition has meant that many mobile raider's sites have been misidentified as those whose material they took.

Foreign items were introduced into "protohistoric" sites by means other than just raiding. The multiple permutations have been discussed exhaustively elsewhere, including some of the ways to distinguish among trade items, objects seized in raids, evidence of a brief (perhaps overnight) stay by a small group, specialized site use, pilgrimage offerings, and so on (e.g., Seymour 2015b; 2017d). Here I will highlight one additional situation—battle sites—in which items from other groups may be introduced into a village setting or multi-group encampment. Once again, because of misimpressions surrounding the indices of warfare (or even the occurrence of it prior to Europeans), evidence of violence is usually only recognized when villagers lost because indices differ substantially when then villagers won (Seymour 2014, 2015a). Many historically referenced groups of the early historic period became allies against the Spaniards and those who served as their auxiliaries. Consequently, battle sites are one context in which evidence of these allied groups and their enemies are expected to occur together in the villages of those they attacked. In one historically recorded instance from 1698 that was noted above, 500 Apache, Jocome, Manso, Suma, and Jano attacked an 80-person Sobaipuri village on the San Pedro River. Analysis of the projectile points and other weapons, their styles, distributions, and breakage patterns has reinforced the identification of distinct styles that correspond to each of the groups reported to be at this battle and designated a battlefield signature that is applicable when the villagers won (Seymour 2011b, 2014, 2015a, 2017e). The prevalence of violence during this period means that many more sites than have been recognized should produce evidence of attackers in the village contexts of their enemies.

Points and pottery are the principal bases for temporal and cultural reconstruction, but they tend to occur infrequently on mobile-group sites (or as noted, may have been introduced in a variety of ways that can confuse a cultural signature), which highlights the need to discern other ways of assigning cultural affiliation and age. One solution has been to consider the potential diagnostic value of other artifact types and their stylistic attributes, specific technological organizations, features types, site layout, and distinct patterns of landscape use and terrain selection. Elsewhere I have discussed many of these characteristics as being sensitive to behavior and identity, including how bifaces and other tools and the debris left behind from their manufacture and maintenance may be diagnostic (Seymour 2002, 2008b, 2010a, 2014, 2016b, 2017d). Components can be distinguished from earlier and contemporaneous ones by considering such attributes as freshness of the flakes, material types selected, unique flaking and stylistic attributes, and knapping technology evident in debitage.

This research is showing that many more attributes are sensitive to behavior and identity than are often considered and thus are useful in recognizing late-occurring components. These alternative diagnostics are critical when assessing assemblages with low densities and diversities. Constructing a repertoire of unconventional diagnostic indicators is especially useful when attempting to reconstruct what might be considered attenuated assemblages. Artifact frequency and diversity is low on many high-mobility sites which are characterized by limited activities because people were moving across a landscape, carrying out daily activities in many different areas. Shortness of stay meant that few items were broken, reworked, discarded, or lost in any one location and the full range of household or daily activities might not have occurred at any one place during any one stay. On sites that were revisited through the years, enough items might be lost or discarded, and features used, that a fuller representation of the household assemblage and activities can be reconstructed. This is the case on the Cerro Rojo site, for example, which, as a large hilltop site was revisited repeatedly through the years by large diverse groups of people (Seymour 2002, 2004, 2008b). Yet, on most sites only a subset of the range of activities is represented. Consequently, the household or task-specific assemblage becomes spatially and temporally segmented, distributed across a number of different sites within a territory. Only when merging the content of several sites inferred to be behaviorally related is it possible to reconstruct the representative assemblage. Doing so can help in (a) identifying a larger constellation of related traits and (b) associating a specific set of traits with a particular group.

It is useful to visualize the constituents of segmented assemblages that are spread across a number of sites as if they were loci within a single site, wherein each locus represents a focus of activity, but also only a subset of a larger activity set. These segmented mobile group assemblages are part of a more expansive activity set. As an illustration of this concept, Figures 5-6 show an item (A, perhaps a point or other diagnostic tool) that is definitively connected to the Apache and that is associated with a second item (B, platform cache) on one site. On a second site, Item A is associated with a third item (C, pottery) suggesting a potential relationship. Then, on a third site, Item B is spatially associated with C indicating a possible temporal and cultural relationship. On a fourth site Item C is associated with D (rock art), and so on, and the elements incorporated as diagnostic can be ever-expanding. In this way, each of the newly diagnostic items is connected to another newly or known diagnostic item on a fifth site. Through these means, and continual crosschecking and field checking, Item A is linked with Item D, and so on. As additional sites are recorded, contexts may be found where Items B and D co-occur and by way of this process the associations are confirmed. In this fashion, a wider range of items can be associated with one another, forming a constellation of traits that is ultimately connected to an archaeological culture group. Through this process, a reconstituted assemblage is reassembled from multiple contexts, and artifacts dispersed across an active landscape are combined into a reconstructed assemblage (see Figure 6). With sufficient iterations of these types of associations, each element of the constellation of traits is tested and cross checked, both for its continued association with the other elements across additional contexts and its

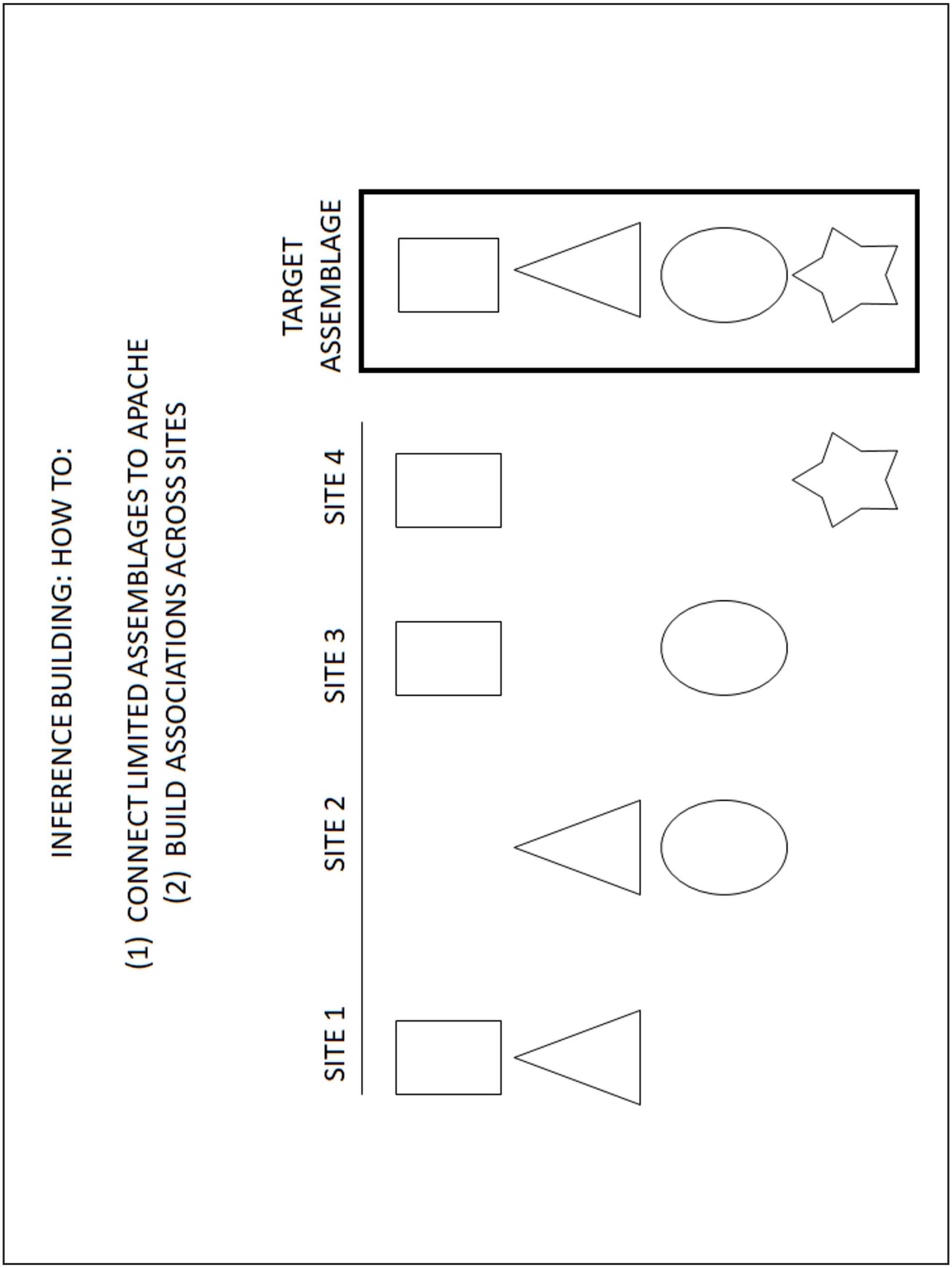

Figure 5: Segmented assemblages are spread across a number of sites as if they were loci within a single site but are only a subset of a larger activity set.

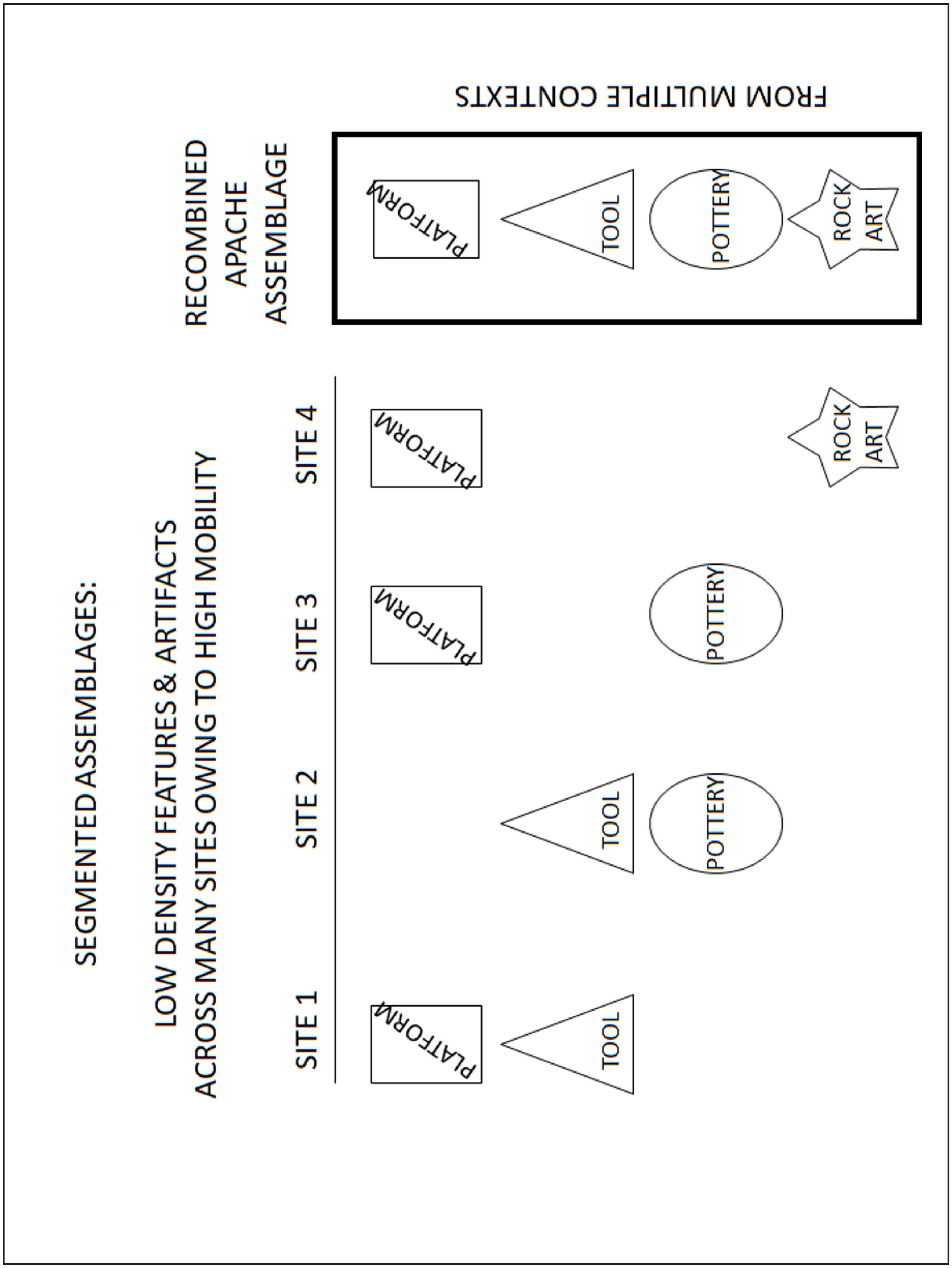

Figure 6: Each newly diagnostic item is connected to another and through this process a wider range of items can be associated with one another, forming a constellation of traits that is ultimately connected to an archaeological culture group.

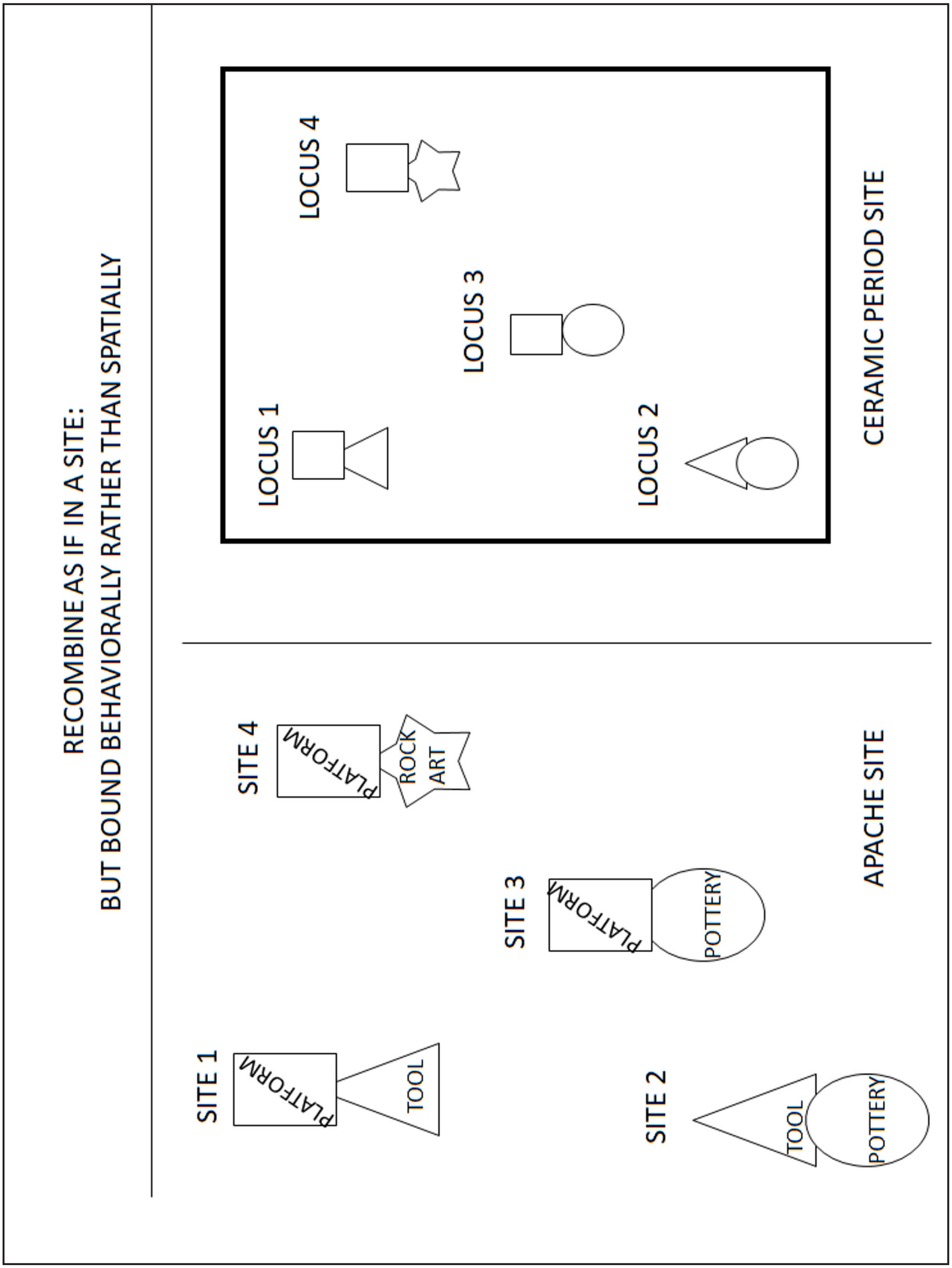

Figure 7: Segmented assemblages, bound together behaviorally rather than spatially.

distinction from those of other time periods and culture groups. By these means, each of these sites forms a subset of a larger behavioral mosaic that can then be combined, as if they are contemporaneous loci within a single site (Figure 7). These segmented assemblages are bound together behaviorally rather than spatially. Individual sites can therefore be assigned to a particular culture group based on the presence of one or more of these items, features, and landscape characteristics and terrain settings (also see Seymour 2002, 2012a).

While not exhaustive, this discussion provides a sense of the ways in which these assemblages can contribute to new understandings if only we step outside perceptions developed for the better-known but very different groups that have already been recognized and studied.

CONCLUSIONS

Because so much has been learned in the past couple of decades, we can say with certainty that so-called "protohistoric" groups such as the Sobaipuri O'odham, Jocome, and Apache were present throughout this region in the late prehistoric period. It is therefore prudent to dispense with the term "protohistoric" unless it is used in a general way to denote something we do not understand, that is too complex to explain otherwise, or that needs to be summarized in shorthand (as it was used above; see Seymour 2011a). Study of these sites and this period demonstrate that low visibility should no longer be equated with inconsequential, although it remains to be learned how consequential these various groups were to the specific course of history. At a minimum I would suggest that since these are some of the groups that survived to present day, their presence and influence must have been quite significant. The Sobaipuri, Jocome, and Apache were important because they successfully passed through a long period of transition that either fundamentally changed or completely disrupted the late prehistoric farming village cultures in the southern Southwest (Seymour 2011a). The Sobaipuri, Jocome, and Apache were very likely agents of the great cultural changes that occurred in the southern Southwest between the late 1200s and the arrival of the Spaniards. Some of these secrets will be revealed in the archeological record if only we ask the right questions and apply the appropriate effort. Processes viewed as occurring in and that define the late prehistoric period, and that have formed the basis of research questions for more than a century, were very likely influenced by these peoples. Importantly, these processes were initiated and were fully underway much earlier than the protohistoric period. If, as has been the case, we focus on the post-1450 period, we will miss the formative basis for these changes. Clearly the processes that define the late prehistoric period—grand scale reorganizations, aggregation, defensive placement, migration and population shifts, and more—were influenced by the presence of these peoples (Seymour 2011a). We do not yet know how, but we do know that each of these groups was present and interacting and so had some impact or influence on regional events. How, in which ways, and to what degree remain to be studied, but we now know to orient our studies by acknowledging that people once invisible were key players in this period.

ENDNOTES

1 Some O'odham groups spell their name O'Odham, O'odham, Oodham, Otam, or Otham. These differences relate to dialect differences throughout the O'odham area.
2 Owing to the shortage of space available it is assumed that the reader is aware of and has availed themselves of the abundant existing literature on the topics summarized in this paper.
3 I am also studying many of the other groups but research is not as far along.
4 Many more chronometric dates from each of the Sobaipuri components are needed to ascertain a more precise timing.

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A REEVALUATION OF MESOAMERICA IN THE SOUTHWEST THROUGH THE EXAMINATION OF HOHOKAM AND NORTHWEST MEXICAN RELATIONSHIPS SOUTH OF THE LOWER SALT RIVER, CENTRAL ARIZONA

Christopher R. Caseldine

Archaeologists have long been interested in the relationships formed between ancient Mesoamerican and Southwestern societies. Citing similarities seen in Mesoamerica, scholars have proposed Southwestern cultural developments arose, in large part, from Mesoamerican influence. Central to previous studies was the identification of Mesoamerican interaction markers. Proponents of prior interaction models contended that the markers were the material record of interactions between Southwestern groups and cultures to the south. The assumption underlying those models held that Mesoamerican ideology was imposed upon Southwestern societies. Critiques of the Mesoamerican interaction models identified data selection and other biases as molding evidence to fit a priori interpretations. In this article, I apply a context-based approach to understand relationships between Southwestern groups and cultures to the south. Relationships with groups to the south are studied by testing whether the interactions better agree with the expectations for focal villages or linear communities using data from selected Hohokam settlements on the south side of the lower Salt River, central Arizona. Analysis of contextual data from those sites signaled that the Mesoamerican interaction markers could be divided into two categories—local development and external origin. It is suggested that the relationships expressed through the interaction markers appear to better align with social boundary cross-cutting of linear communities than centralized redistribution through focal villages. Further, in the study context, I argue that the interaction markers do not denote relationships with Mesoamerica, but rather, local manipulation of pan-regional ideas and connections to Northwest Mexico. The article concludes with a call for careful review of artifact contexts, both their recovery location and their use, to understand relationships between Northwest Mexican and Southwestern societies.

In this article, I approach the study of relationships between ancient Southwestern societies and cultures to the south in a different way than previous scholars (e.g., Di Peso 1974; Gilman et al. 2014; Kelley and Kelley 1975; Lister 1978; Reyman 1978; Wilcox 1986a). I chose to shed sociopolitical wrappings of previous studies, to focus on context to guide the interpretation of the role of Mesoamerican indicators in Southwestern settings. An area that Erik Reed famously described as Durango, Colorado, to Durango, Mexico, and Las Vegas, Nevada, to Las Vegas, New Mexico (Cordell and McBrinn 2012:19). I focus this study by concentrating on one Hohokam area, located on the south side of the lower Salt River (Figure 1).

This study begins by defining markers of interaction between the Southwest and cultures to the south. As discussed below, the types of interaction markers differed somewhat among previous scholars (e.g., Crown 1991; Di Peso 1974; Gladwin 1937; Haury 1945a, 1945b, 1976; Lister 1978; Nelson 1986), but a reasonable list for the Hohokam was generated. Next, so called Mesoamerican interaction markers are inventoried for each study site south of the lower Salt River. The study then turns the focus toward Mesoamerican interaction markers discovered at the village of Los Muertos to contextualize possible relationships between individuals south of the lower Salt River and Northwest Mexico. Although the main occupation of the village was during the late Classic Period, and after relationships between the Hohokam and elsewhere are thought to have broken down (e.g., Abbott 2003), Los Muertos had a relatively high frequency of interaction markers.

I use the term Mesoamerican interaction marker out of convenience, given the extensive literature detailing

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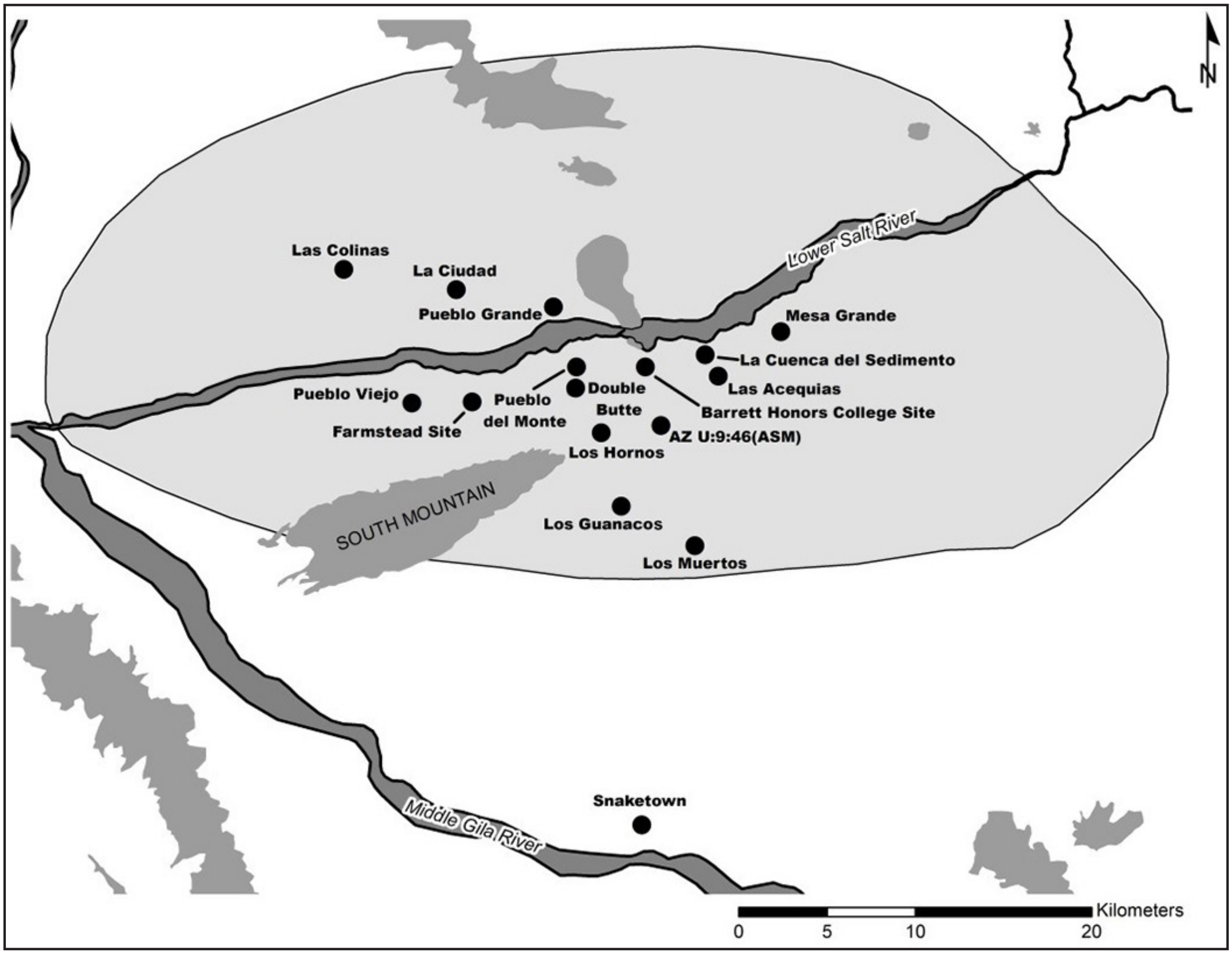

Figure 1. Location of sites discussed in this article. The gray shading on inset map denotes the lower Salt River Valley, Arizona.

relationships between the Southwest and Mesoamerica. As McGuire and others have noted (Haury 1945a; McGuire 1980, 2011; McGuire and Villalpando 2007), the interaction markers likely have little to do with the Mesoamerican core, which extended from the Basin of Mexico to the Yucatan Peninsula. Instead, items and ideas that have Mesoamericaness attributed to them were likely local manifestations of pan-regional ideas, even if they originally appeared in the Mesoamerican core.

My focus on interactions among Southwestern societies and groups to the south, rather than with Mesoamerica leads to the following research question: were relations that the Hohokam had with groups to the south, especially in Northwest Mexico, centered on focal villages, or did the interactions cross-cut irrigation system boundaries, as expected for linear communities, south of the lower Salt River? Previous ceramic exchange studies along the lower Salt River revealed that settlements in the same irrigation system had a more mixed plain ware assemblage than if a focal village were influencing exchange patterns in the system (Abbott et al. 2006). The research question therefore examines whether social boundary cross-cutting expected for linear communities may have also manifested in the relationships between the Hohokam south of the lower Salt and societies to the south. As discussed below, only a few Mesoamerican interaction markers may have been the result of relationships between the Hohokam and groups to the south, likely in Northwest Mexico. Many raw materials for Mesoamerican interaction markers bore evidence of the Hohokam altering those items to meet their needs. And of those that were not manufactured in the Hohokam world, most, if not all, came from contacts in Northwest Mexico (McGuire 2011; McGuire and Villalpando 2007). I argue that farmers in each Hohokam settlement south of the lower Salt River fostered relationships with Northwest Mexican societies for multiple reasons, rather than previous exclusionary explanations of Mesoamerican dominance or elite power legitimization (e.g., Di Peso 1974; Gilman et al. 2014; Kelley and Kelley 1975; Lister 1978; Mathiowetz 2018, 2019; Reyman 1978).

MESOAMERICAN RELATIONSHIPS IN THE ANCIENT SOUTHWEST

For over a century, Southwestern archaeologists have been captivated and perplexed by how Mesoamerican cultures articulated with Southwestern societies (e.g., Di Peso 1974; Haury 1945a, 1945b; McGuire 1980, 1986; Nelson 2006:345–346; Nelson 1981, 1986). Although parsed into separate spheres of research, there was an inherent belief that the Mesoamerican societies were intertwined with the development of the Southwest. The debate that sprung forward, exemplified by the controversy surrounding the pochteca model (see McGuire 1993; Nelson 1981, 1986), focused on who were the Mesoamerican influencers and what was their means of influence (see McGuire 1980 for a detailed summary). The scholars overwhelmingly characterized Southwestern groups in a recipient role, whether imposed upon by Mesoamerican overlords or used to legitimize social standing (McGuire 1980). In essence, Southwestern culture was portrayed as subordinate to Mesoamerica, with some scholars going so far as to assert that Mesoamerican groups were the prime catalyst in the development of Southwestern groups (e.g., Kelley and Kelley 1975:186).

Four aspects underlaid previous studies of Mesoamerican and Southwestern connections. First, many scholars applied a neo-evolutionary sociopolitical assumption to their interpretation of the interactions. Key to the assumption was the belief that either distant Mesoamerican overlords were directly shaping the cultural development of Southwestern groups (e.g., Di Peso 1974; Kelley and Kelley 1975; Lister 1978; Reyman 1978) or local leaders used items from afar, either literally (e.g., copper bells) or figuratively (e.g., platform mound ideology), to legitimize their social position and power (e.g., Gilman et al. 2014; McGuire 1980, 1986; Nelson 1986; Wilcox 1986a). Items used in rituals were noted (e.g., Doyel 1991:227-228; Foster 1986; Wilcox 1986a:142), based on their occasional discovery in identified ceremonial contexts, but the stated purpose for these items was to further local elite agendas (e.g., McGuire 1980, 1986; Nelson 2006; Nelson 1981, 1986; Wilcox 1986a). Scholars were therefore transfixed by Southwestern societies highly valuing distant items, whether imposed upon them or used for personal gain. As characterized, the Southwest was a land of subordination (e.g., McGuire 1986:251–253).

Second, critiques of Mesoamerica and Southwest interaction models (Haury 1945a; McGuire 1980, 2011) noted a high occurrence of data selection. Emil Haury stated that Mesoamerican connections were “drawn chiefly from Central Mexico, involving a jump of over a thousand miles and an almost complete disregard of the intervening area” (Haury 1945a:70). Haury suggested that the tenuous data used to support connections models were spawn from a lack of archaeological investigations in Northwest Mexico. McGuire (1980, 2011) drilled down further into the stretched connections and found that the problem extended beyond data insufficiency. Scholars assumed Mesoamerican culture was homogenous, so ideologies and artifactual styles from across Mesoamerica were amalgamated into a single model. For example, feathered serpent ideology from the Basin of Mexico was interwoven with artistic motifs from the Dominican Republic (McGuire 1980:5; see also McGuire 2011 for more recent examples). Scholars essentially relied on an eye test to support connections, even if other lines of evidence were absent (e.g., Lowell 1990; McGuire 2011:25).

Third, Mesoamerican and Southwestern interactions were discussed in terms of regions. Mesoamerican relationships were proposed as entailing a package of ideology, and associated artifacts were thought to have been accepted across the Southwest or at a culture region scale (e.g., Di Peso 1974; Doyel 1986:53–58). Pochtecha traders stationed at Casas Grandes usurped Hohokam control of Southwestern shell exchange or Hohokam platform mounds ascended to a central ceremonial role due to Mesoamerican groups, for example (Di Peso 1974:627–628). Similar to the assumed homogeneity of Mesoamerican culture, Southwestern regions were sanitized of variability, allowing cultural traits to be picked from dispersed settlements across the region or single well-documented settlements (e.g., Snaketown for Hohokam and Chaco Canyon for Ancestral Puebloan). As a consequence of grand Mesoamerican models, subregional and site level variability were ignored.

Fourth, the assumption of sociopolitical hierarchy, frequent use of data selection, and regional focus all point to the conclusion that Mesoamerican connection models served the purpose of providing an evolutionary explanation for the development of the Southwest. Although Southwestern groups achieved great feats (e.g., Hohokam large-scale irrigation), they lagged behind the “high culture” of Mesoamerica (McGuire 1980:5). Once Southwestern groups became sedentary, their cultural development was portrayed as only changed though first influence and then direct intervention by Mesoamerican societies (McGuire 1980:4; Nelson 1981). Cultural developments were at least tangentially attributed to Mesoamerican societies, beginning with the importation of maize and other Mesoamerican crops. Although later researchers acknowledged local agency in the acceptance and use of Mesoamerican items (e.g., Crown et al. 2015; Doyel 1986; McGuire and Villalpando 2007; see Wilcox 1986b), Mesoamerica still loomed over Southwestern history. The models therefore placed primacy on Mesoamerica for what the Southwest became. The interaction intensity, whether direct or indirect, was the point of debate and not why Southwestern societies established and maintained relationships with Mesoamerican groups.

As pointed out by Haury (1945a) and McGuire and Villalpando (2007), interpretations of relationships between the Southwest and Mesoamerica were shaped by the "great unknown sea of northwest Mexico" (McGuire and Villalpando 2007:57). The growing number of archaeological investigations in Northwest Mexico are filling in the once substantial gaps in knowledge (e.g., McGuire and Villalpando 2007; see articles in McGuire and Villalpando 2016). Those studies have revealed that although the Southwest shares ideological concepts with Mesoamerica (e.g., serpent deities and cosmological concepts of directionality), the northern Southwest and southern Southwest trace their connection with purported Mesoamerican ideology through areas outside the Mesoamerican core, particularly West Mexico and the Gulf Coast (Randall McGuire, personal communication 2020). The growing body of literature for the archaeology of Northwest Mexico has led to current models for the spread of Mesoamerican ideology and material culture through direct travel to the Gulf Coast (e.g., Crown et al. 2015; Crown and Hurst 2009), possibly during esoteric knowledge journeys (e.g., Gilman et al. 2014); transmission from West Mexico through Sonoran relations (e.g., McGuire 2011; McGuire and Villalpando 2007); and Paquimé as a conduit for the transmission between Mesoamerica and the Southwest (e.g., Mathiowetz 2018, 2019; Somerville et al. 2010). Pertinent for my study, the relational link to Mesoamerica for the Hohokam was West Mexican cultures through groups in Northwest Mexico (McGuire 2011:32; McGuire and Villalpando 2007:59).

SITUATING THE HOHOKAM IN SOUTHWESTERN AND NORTHWEST MEXICAN RELATIONSHIPS

The largest socially cohesive unit among riverine Hohokam was the irrigation system (Abbott 2000; Caseldine 2020; Howard 2006; Hunt et al. 2005; Woodson 2010). Ceramic exchange studies have demonstrated that Hohokam irrigators had stronger social ties with members of their irrigation systems than with other systems or the broader region as time progressed (Abbott et al. 2006). Extensive work by Abbott (2000, 2003) has shown that inter-system exchange was robust against profound changes to regional exchange patterns. Abbott revealed that despite social balkanization during the pre-Classic/Classic Transition (Table 1), Canal System 2 farmers maintained a strong exchange network up and down the system.

Table 1. Hohokam Cultural Sequence Chronology*

General Period	Period	Phase	Date Range (A.D.)
	Pioneer	Estrella	500–600
		Sweetwater	600–700
Preclassic		Snaketown	700–800
	Colonial	Gila Butte	800–850/900
		Santa Cruz	850/900–1000
	Sedentary	Sacaton	1000–1100
Preclassic/ Classic Transition			1070–1100/1150
	Classic	Soho	1100/1150–1300
Classic		Civano	1300–1450

*Based on Abbott (2002); Chenault(2000); Dean (1991); and Doyel (2000).

My study area focus is south of the lower Salt River. Scholars thought that nearly all the irrigation infrastructure on the south side of the lower Salt was organized into the expansive Canal System 1 (Howard 2006; Turney 1929). As conceived, it was the largest system in the Hohokam region and likely one of the largest single systems in the ancient preindustrial world. Research I carried out revealed that Canal System 1 was not a single irrigation system, but four: Crismon System, Sedimento System, Riverview System, and Los Muertos System (Caseldine 2020). Unlike the richly studied and described Canal System 2 (e.g., Abbott 2000; Abbott ed. 2003; Howard 1990; Howard and Huckleberry 1991), very little archaeological synthesis had occurred on the south side of the river.

The sites selected for my study are relatively close in proximity, but they are located in three different irrigation systems. Contrary to an assumption of social relationship closeness positively correlating to physical distance, Abbott (2000:153–156) found that the Pueblo Salado ceramic assemblage contained a higher percentage of plain ware pottery from south of the lower Salt River than settlements also located on the north side of the river. Pueblo Salado's location should have placed it within the Canal System 2 irrigation community, but the ceramic exchange patterns suggested otherwise (Abbott et al. 2006:293).

Abbott's (2000) finding that irrigation system boundaries, rather than physical distance, likely structured social relationships among lower Salt River

Hohokam, was later tested by Abbott and colleagues (Abbott et al. 2006). The goal of Abbott and colleagues' study was to test if the exchange patterns observed by Abbott (2000) were resultant from focal village or linear community political organization. The focal village model "posits numerous political communities along the Salt River, each organized around a single large village with monumental architecture surrounded by smaller settlements," whereas the linear community model "posits many fewer but larger political communities in the valley, each coterminous with a multi-village irrigation cooperative stretched out along the canal routes" (Abbott et al. 2006:286). The key factor that differentiated the focal village and linear community models was ceramic assemblage homogeneity (Abbott et al. 2006:297–298). If lower Salt settlements were politically organized according to the focal village model, then smaller sites (e.g., farmsteads and hamlets) and neighboring villages with monumental architecture (platform mounds for their study) should have a similar mixture of pottery varieties from elsewhere in the Hohokam world. Abbott and colleagues (Abbott et al. 2006) found instead that the study sites (Farmstead and Pueblo Viejo in Canal System 7) differed in the mixture of pottery varieties from elsewhere in the Hohokam world, despite plain ware exchange patterns consistent with membership in the same irrigation system. Abbott and colleagues (Abbott et al. 2006:299) therefore concluded that in the context of their study, focal villages did not define the social relations of surrounding communities. Instead the social relationships formed by the irrigator households were likely multifaceted and cross-cut irrigation system boundaries.

The applicability of Abbott's ceramic exchange work to the study of Northwest Mexican and Hohokam interactions is an expectation of heterogeneity. I argue that a test of focal village and linear community models is equally relevant to the study of Northwest Mexican and Hohokam relationships. For this study, I examined the material assemblages of eight sites on the south side of the lower Salt River (Figure 2). The selected sites represent a range of settlement types, from field houses to villages; time; and irrigation system membership.

MESOAMERICAN INTERACTION MARKERS AMONG THE HOHOKAM SOUTH OF THE LOWER SALT RIVER

According to Ben Nelson, Mesoamerican interaction markers are "a variety of archaeological patterns that are reminiscent of Mesoamerican counterparts" (Nelson 2006:345). Scholars have proposed a multitude of markers in support of the various Mesoamerican interaction models (Table 2). Nearly every aspect of Southwestern cultural traits has been attributed to Mesoamerican societies, leading researchers to suggest 11 to nearly 40 interaction markers (see Table 2). McGuire's (1980) detailed review of Mesoamerican interaction markers suggested that only 11 markers were most likely the result of relationships between Southwestern societies and cultures to the south. McGuire (1980, 2011:25) discounted many proposed interaction markers because they: extended deep in ancient Southwestern history, the Mesoamerican traits came from disparate locations in Mesoamerica, or the traits were not part of the same suite of cosmological beliefs. Defining archaeological context at various levels, from the site to the regional level, was therefore vital to McGuire's critique. Although McGuire focused on interrogating claims of pochteca intervention in the development of Chaco Canyon (McGuire 1980), and later Puebloan religion (McGuire 2011), his discounting of many purported Mesoamerican interaction markers is also applicable for the Phoenix Basin Hohokam.

A total of nine possible Mesoamerican interaction markers have been documented south of the lower Salt River (Table 3). Analyzing marker occurrence at the site level, rather than the Hohokam region as a whole, revealed three results. First, the markers can be separated into two categories – items that had extensive developmental histories among the Hohokam (local development) and markers that were likely made in West Mexico (external origin). Second, items made in West Mexico were dispersed widely among sites south of the lower Salt. When more than one type of marker occurred at a site, they were likely located in different locations. Third, as I will contend in the discussion, it is probable that the purported Mesoamericaness of the interaction markers denote Hohokam connections with Northwest Mexico, and possibly West Mexico, rather than the Mesoamerican heartland. As such, Mesoamerican ideology that radiated from the Mesoamerican core was filtered and molded by groups in West and Northwest Mexico before reaching the Hohokam, who further manipulated it for their own purposes (McGuire 2011; McGuire and Villalpando 2007).

Artifact types and other markers that hold membership in the first category were cylindrical vessels, tripod vessels, comales, ball courts, and platform mounds. The two types of vessels are members of this category because the forms have long production histories and appeared at different times. Cylindrical vessels were first manufactured during the Pioneer Period and became a common form after A.D. 1000, corresponding with red ware production (Haury 1976:Figure 12.48). Tripod vessel production began during the Colonial Period (Haury 1976:Figure 12.26). As with other members of this

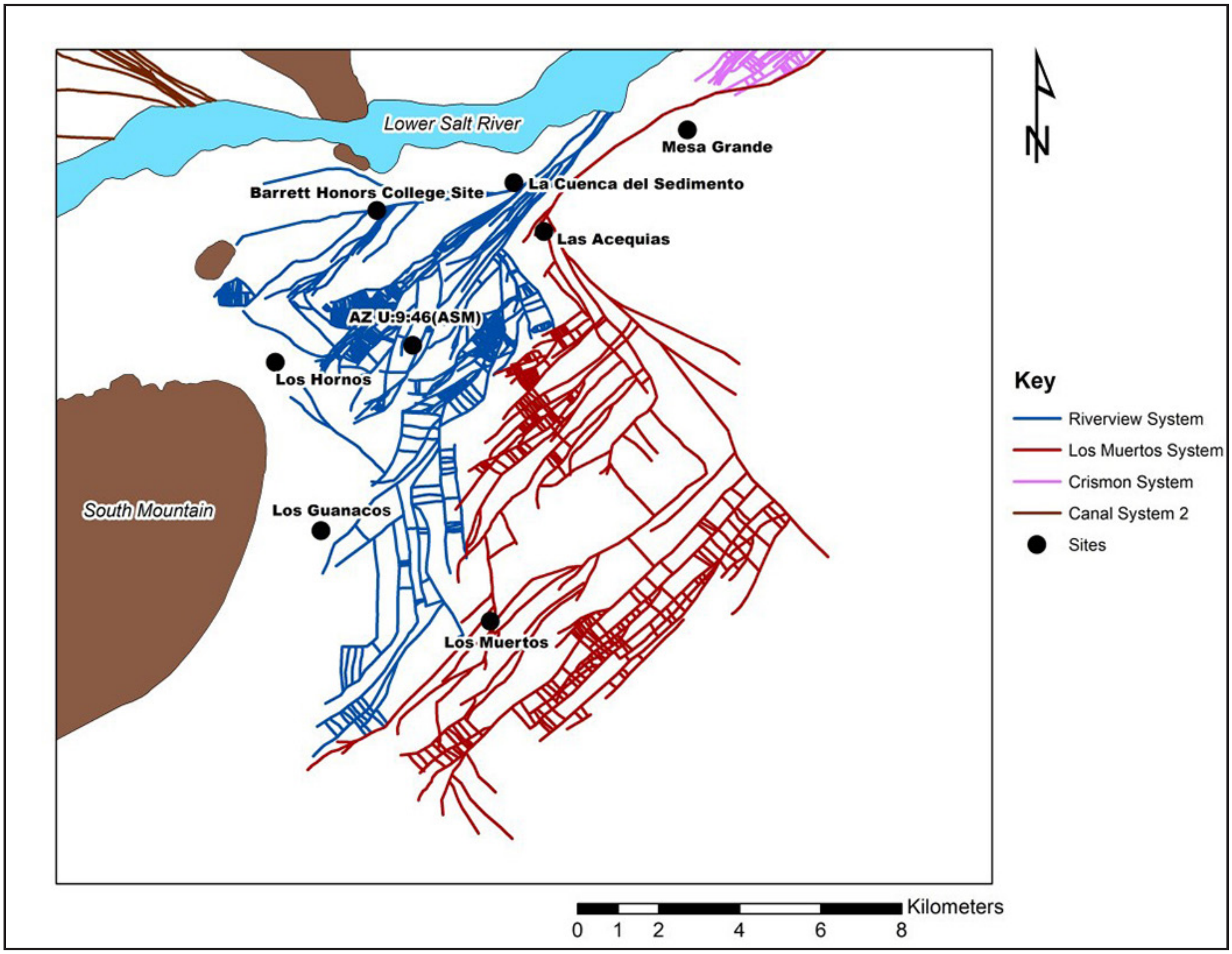

Figure 2. Study sites and associated Hohokam irrigation systems. (Modified from Caseldine 2020)

category, roots for cylindrical and tripod vessels extending from West and Northwest Mexico cannot be ruled out (Crown et al. 2015; Crown and Hurst 2009; McGuire and Villalpando 2007), but once those forms were integrated into the Hohokam pottery shape repertoire, they appear to have developed to serve local needs.[1]

Comales, named because of their similarity to flat tortilla-making ceramic slabs found in both West and Central Mexico (McGuire and Villalpando 2007), may represent a change in culinary technology (e.g., portable maize cakes), but at local-scale (Haury 1945b:109–111, 1976:348). Haury (1945b:110) notes that comale finishing techniques differed depending on location in the Southwest. Hohokam comales were hand smoothed, whereas Ancestral Puebloan comales were smudged and high polished. The restriction of comales to domestic areas and the absence of traders extensively traveling between Mesoamerica and the Hohokam region hints at local production. Again, the Hohokam-molded comale was used to meet local needs, regardless if the original idea came from the south.

The final two markers of the local development category, ball courts and platform mounds, have been identified as Mesoamerican in origin (e.g., Di Peso 1974; Haury 1976:77, 79, 93; Wilcox 1991; Wilcox and Sternberg 1983). Initial visual and functional similarities give way to discernable differences when Mesoamerican and Hohokam counterparts are carefully examined. Ball courts played a central ceremonial role through much of ancient Mesoamerican history, but the kinds of games played by the Aztec and Maya were not the only ball games played in the greater Mesoamerican world (e.g., Leyenaar 2001; Wilcox 1991). Ethnographic accounts in northern Mexico document different kinds of ball games than those played in Central Mexico and the Yucatan (e.g., Ferdon 1967; Leyenaar 2001). Critically, the games

Table 2. Proposed Items of Mesoamerican Origin/Influence

Crown (1991)	Di Peso (1974)	Di Peso (1974) cont.	Gladwin (1937)	Haury (1945a)	Haury (1945b)	Haury (1945b) cont.	Haury (1945b) cont.
Agricultural crops	Cochineal	Marine shell	Ball courts	Ball courts	Ball courts	Footed vessels	Stone carving
Ball courts	Cocoa	Meso-american pottery	Copper bells	Bird-serpent symbolism	Bossed decoration	Gauze textile weave	Tie-dying textile
Comales	Compound architectural style	Mosaic plaques (mirrors)	Ear plugs	Copper bells	Candeleros	Griddles	Weft-wrap textile openwork
Copper bells	Cotton	Panpipe	Figurines	Figurines	Chak mool-like figure	Handled censer	
Macaws	Earspools	Platform and tabular tobacco pipes	Meso-american pottery	Griddles	Chipped crescents	Legged vessels	
Marine Shell	Feathers	Pottery motifs	Mosaic plaques (mirrors)	Legged vessels	Copper bells	Macaws	
Meso-american pottery	Flake knives	Pyramidal mound structures	Nose plugs	Mosaic plaques (mirrors)	Corn	Mano with overhanging ends	
Modeled spindle whorls	Hand drums		Tetrapod trays	Nose plugs	Cotton	Mosaic discs (mirrors)	
Mosaic mirrors	Hand modeled clay figurines		Tripod vessels	Rubber ball	Cross-shaped stones	Nose plugs	
Palettes	Human effigy in shell			Spindle whorls	Ear plugs	Pictorial elements	
Platform mounds	Jade beads			Stone carving	Effigy vessels	Pottery	
Shell trumpets	Jaguar skins				Figurine with vessel on head	Shaped mortar	
	Mantles				Figurines	Spindle whorls	

Haury (1976)	Haury (1976) cont.	Haury (1976) cont.	Lister (1978)	Lister (1978) cont.	Lister (1978) cont.	Nelson (1986)
Agricultural crops	Effigy palette	Mosaic plaques	Altars in central courts	Macaws	Tree of life	Arrow points
Ball courts	Effigy vessels	Nose plugs	Architectural alignments	Mosaics	Tri-walled structures	Asbestos
Bird-snake motif	Feathered head dress	Platform mounds	Bone pins	Painted wood (altars)	T-shaped doorways	Black steatite objects
Burden carrier	Figurine with receptacle	Pottery motifs	Canals	Platform mounds	Turkeys	Carved bone hairpins
Canals	Figurines	Rubber balls	Ceremonial canes	Pseudo-cloisonne	Turquoise	Copper bells
Carved shell	Handled bowl	Shaped metates	Conch trumpets	Roads		Human head figurines
Censers	Heavy walled vessels	Stone axe	Copper bells	Rubble core masonry		Macaws and parrots
Chac mool figurine	Human effigy in shell	Stone club	Cylinder jars	Seating discs for posts		Mesoamerican pottery
Cipactli	Intertwined snake motif	Stone sculpture	Dams and reservoirs	Shell beads		Mosaic mirrors
Comales	Legged vessels	Turquoise mosaic	Effigy vessels	Signal stations		Pecten vogdesi pendants
Compound architectural style	Macaws		Horned serpent motif	Square columns		Shell overlay
Copper bells	Modeled spindle whorls		Incense burners	Stamps or seals		Shell trumpets
Ear spools	Molcahete		Iron pyrites	Tower kivas		

Table 3. Mesoamerican Interaction Markers among the Hohokam South of the Lower Salt River*

		Local Development					External Origin				
Site	Site Type	Cylindrical Vessels (Beakers)	Tripod Vessels	Comales (Griddles)	Ball courts	Platform Mounds	Whole Marine Shell	Shell Trumpets	Macaw Imagery	Copper Bells	Site Total
Barrett Honors College	Field House Site	–	–	–	–	–	–	–	–	–	0
AZ U:9:46(ASM)	Farmstead	–	–	–	–	–	Present	–	–	–	1
La Cuenca del Sedimento	Farmstead	–	–	–	–	–	Present	–	–	–	1
Las Acequias	Hamlet	–	–	–	–	–	Present	Present	–	–	2
Los Guanacos	Village	–	–	–	Present	–	Present	–	Present	–	3
Mesa Grande	Village	–	–	Present	Present	Present	Present	–	–	–	4
Los Hornos	Village	–	–	Present	Present	Present	Present	–	–	Present	5
Los Muertos	Village	Present	Present	Present	–	Present	Present	Present	Present	–	7
Indicator Total		1	1	3	3	3	7	2	2	1	

* Data from Haury (1945a); Herskovitz and Hartmann (1981); Nelson (1991); and Steinbach et al. (2008)

could be played in open areas without the formalized boundaries seen in the heart of Mesoamerica (Elson 2007:52; McGuire and Villalpando 2007:60–61).

Wilcox (1991:121) argued that Hohokam ball courts were "independently invented" to solve local organization issues that arose from large-scale irrigation, despite the idea that ball games diffused north from Mesoamerica. Side-by-side comparison of Hohokam to Mesoamerican ball courts gives credence to developmental independence (Ferdon 1967:4–7). Emerging during the Colonial Period, Hohokam ballcourt architectural style included the use of infield markers and rounded berms that formed an oval. Conversely, contemporaneous ball courts in Mesoamerica (Epiclassic in the Basin of Mexico and Classic in the Maya Lowlands) were uniformly either I-shaped or strait-walled alley types (McGuire and Villalpando 2007:60–61). Although identified as facilitating ball games in both areas, the backdrop for the games stylistically differed. I-shaped ball courts reached as far north as the Casas Grandes area (Wilcox 1991), so it is reasonable to assume that the architectural style could have been present among the Hohokam if the game were a direct import from the core of Mesoamerica. The diversity of ball games and architectural distinctiveness of Hohokam ball courts hint that ball game ideology spanned the greater Hohokam and Mesoamerican region, but ball courts were tailored to address local needs. As such, ball game ideology was not a single set of beliefs held up by a standardized structure. Ball courts were therefore just as much Hohokam in development as Mesoamerican in origin.

Hohokam distinctiveness extends to platform mounds. A fundamental difference between Hohokam and Mesoamerican platform mound use is the relationship to ball courts (Elson 2007:51–52). Platform mounds in the Mesoamerican core were often accompanied by ball courts (e.g., Monte Alban, Tula, and Tenochtitlan). In contrast, formalized Hohokam platform mound ceremonialism occurred several generations after ballcourt ritual had ceased (Abbott 2003). Hohokam platform mound use may have started as early as the Pioneer Period (Haury 1976), but a standard set of beliefs did not spread across the Hohokam world until the late Classic Period (Downum and Bostwick 2003; Gregory 1988). If formalized platform mound ceremonialism were a direct import from Mesoamerica, then ballcourt ritual would also be expected. The temporal disconnect between Hohokam ball courts and formalized platform mounds signals that the formalized platform mound was an outgrowth of Hohokam cosmological developments.

A key aspect of local development markers is they manifest in the Hohokam archaeological record as a likely result of local needs and beliefs. Mesoamerican origins cannot be ruled out with these data, but rather, the lines of evidence provide a reasonable alternative. It is plausible that this category of Mesoamerican interaction markers were ideas that cross-cut Hohokam and Mesoamerican boundaries. Assuming that Northwest Mexico was both a geographic and social intermediary between the Hohokam and the Mesoamerican core, then these Mesoamerican markers are not a single package exported on the backs of traders from Mesoamerica (McGuire 2011; McGuire and Villalpando 2007). Rather, the local development markers are local manifestations of overarching ideology with local relevance. In sum, the Hohokam and societies in Northwestern Mexico and Mesoamerica participated in pan-regional beliefs, rather than groups in Mesoamerica impose ideology onto the Hohokam.

The second category of Mesoamerican interaction markers, external origin, provides a potentially fruitful avenue for studying Hohokam and Northwest Mexican relationships. The four origin markers used in this study were whole marine shell, shell trumpets, macaw imagery, and copper bells - all of which could and likely did come from Northwest or West Mexico, rather than the Mesoamerican core (McGuire 2011; McGuire and Villalpando 2007). A striking result of the occurrence of external origin markers is the apparent correlation among site complexity and marker presence. The least structurally complex settlement type, a field house site in the La Plaza area (Barrett Honors College Site; Steinbach et al. 2008), had neither local development nor external origin markers. These types of sites are thought to be used short-term by a single household during agricultural activities (Cable and Mitchell 1988:396), so unsurprisingly, no markers were discovered.

Increasing settlement complexity to farmsteads and hamlets, which housed two or more households and had formalized settlement features (e.g., trash mounds, central cooking areas, and cemeteries; Cable and Mitchell 1988:397–398), led to the identification of whole marine shell. Bayman (1996) found that shell acquisition was not the restricted prerogative of any one part of Hohokam society (e.g., elites), as would be expected for the focal village model. Rather, households acquired shell items through personal connections in Northwest Mexico. In a result reminiscent of ceramic exchange patterns found in Canal System 7 (Abbott et al. 2006), the shell species were more diverse than if central redistribution occurred (Bayman 1996).

Data for eight sites was tabulated from two pertinent site reports (Herskovitz and Hartmann 1981; Steinbach et al. 2008) and Richard Nelson's (1991) detailed study of Hohokam shell exchange and artifacts. The data revealed a high species diversity of marine shell at some sites south of the lower Salt River (Table 4). La Cuenca del Sedimento (farmstead) and Las Acequias (hamlet) were found to have equal to or greater than species diversity than sampled villages (Los Hornos and Mesa Grande), except for Los Muertos. Although Los Muertos was a large settlement during the late Classic Period, making it a potential focal village, the evidence discussed below better aligns with linear communities than the focal village model.

Los Muertos is unusual, both in its location south of the lower Salt River and elsewhere in the lower Salt River Valley, in that it provides site-level details not available for other settlements. Unlike other villages occupied during the Classic Period, which were inhabited during the pre-Classic, Los Muertos does not appear to have earlier settlement deposits. Based on excavations conducted by the Hemenway Expedition (Brunson 1989; Haury 1945b) and irrigation system reconstructions (Caseldine 2020), Los Muertos was established no earlier than the early Classic Period. However, the main occupation of the village was during the late Classic Period.

Unfortunately, the excavation methodology used by the Hemenway Expedition lacked a detailed focus on vertical stratigraphic context (e.g., if artifacts were found on floors or fill deposits; Haury 1945b:15–16). Despite this, relative locations of external origin markers are known (e.g., the residential compound they were recovered from). The relative frequency of Mesoamerican interaction markers was found to be dispersed across the village (Figure 3). The three external origin markers (three whole shells, one shell trumpet, and one instance of macaw imagery) were single occurrences at different residential compounds, although local development markers could also be present with the origin markers. The most striking aspect of the external origin markers was that they were not found at the platform mound. Many Hohokam researchers contend that socially elevated elites positioned themselves atop platform mounds by the late Classic (e.g., Elson 1998; Crown and Fish 1996; Fish and Fish 1991). They asserted that those elites legitimized their power through platform mound ceremonial performance.

If Hohokam elites were central nodes in Hohokam and southern relationships, then external origin markers of those interactions should have been housed in the platform mound compound area (Rice 2000; cf. Gilman et al. 2014). Instead, whole marine shell, the macaw effigy fragment, and the shell trumpet of known context were held by non-platform mound households. In particular, the shell trumpet runs counter to the Hohokam elite nodal model because it was found at one of the furthest eastern village compounds. Shell trumpets have been documented historically elsewhere in the Southwest as having an important role in ritual performance (Mills and Ferguson 2008), so if those historic analogs are applicable to Los Muertos, then the shell trumpet household would have held an essential role in platform mound ritual.

I have argued elsewhere that Hohokam ritual was underlaid by what I term as "dispersed centrality" (Caseldine 2019; also see Rice 2016:42–43). The key aspect of the concept is that no one individual or household had complete control of esoteric knowledge and ceremonial performance. Instead, complimentary ceremonial responsibilities were shared by many households and performed at multiple locations. In this model, each ceremonially important household carried out their ritual duties at the benefit of the wider community.

Using the concept of dispersed centrality as a guide for analyzing the distribution patterns of Mesoamerican interaction markers at Los Muertos reveals that Hohokam and Northwest Mexican relationships were not nodal. Although households with Mesoamerican

Table 4. Marine Shell Diversity Found South of the Lower Salt River*

Species	Barrett Honors College	AZ U:9:46 (ASM)	La Cuenca del Sedimento	Las Acequias	Los Guanacos	Mesa Grande	Los Hornos	Los Muertos
Glycymeris	X	X	X	X	X	X	X	X
Laevicardium	X	X	X	X	X	–	X	X
Olivella	X	X	X	X	X	–	X	X
Conus	–	–	–	X	–	X	X	X
Argopecten	–	–	X		–	–	–	X
Pecten	–	X	–	X	–	–	X	X
Turritella	–	–	X	–	–	–	–	X
Cerithium	–	–	–	–	–	–	X	X
Oliva	–	–	–	–	–	–	–	X
Agaronia	–	–	–	–	–	–	–	X
Certithidea	–	–	–	X	–	–	–	X
Haliotis	–	–	X	–	–	–	X	X
Nassarius	–	–	–	–	–	–	–	X
Columbella	–	–	–	–	–	–	–	X
Trivia	–	–	–	–	–	–	–	X
Vermetus	–	–	–	X	X	–	X	X
Spondylus	–	–	–	X	X	–	–	X
Protothaca	–	–	X	–	–	–	–	–
Pteria/Pinctada	–	–	X	–	–	–	–	–
Total	3	4	8	8	5	2	8	17

*Data from Herskovitz and Hartmann (1981); Nelson (1991); and Steinbach et al.(2008). Inventoried shell includes whole marine shell, worked pieces, and fragmentary items.

interaction markers may have held social importance, none aggressively displayed their connections with societies to the south (e.g., no household had multiple external origin markers).

The suppression of external displays of external origin markers fits well with results from Rice's (2016) study of Hohokam mortuary practices. Rice identified a disproportionate frequency of inhumations in adobe compounds vis-à-vis communal cemeteries during the Classic Period. Unlike the mix of inhumations and cremations within communal cemeteries, burials placed within compounds were nearly always inhumations. Citing differences in associated funerary items in communal cemeteries and compounds, with more elaborate funerary assemblages being found in compound areas, Rice (2016:3) suggested that there was a tension between Hohokam ideology and religious beliefs. Placing an individual of elevated social status within a walled compound, and beyond the purview of the surrounding community, allowed living relatives to note disproportionate status while maintaining a "fiction of egalitarian ethos" (Rice 2016:3). The dispersal and restricted display of external origin markers within compounds away from the Los Muertos platform mound may, therefore, reflect a suppression of public displays of individual external connections.

One of the most intriguing details about Mesoamerican interaction markers at Los Muertos is that they occurred at all. The minuscule quantities of external origin markers and pottery types across the lower Salt River indicates that interactions between the Hohokam and groups to the south declined through time. The Phoenix Basin Hohokam appear to have become very insular after the pre-Classic. Extra-regional relationships became ephemeral to non-existent as time progress. As a primarily late Classic Period village, Mesoamerican origin markers at Los Muertos should have been absent, excluding Hohokam identity entwined shell (Neitzel 1991:187–189). Los Muertos therefore should have exhibited exclusionary local exchange patterns (e.g., little to no exchange with individuals beyond their irrigation system).

I argue that what is absent at Los Muertos is vital for reconstructing relationships between the Hohokam and groups to the south. Unlike marine shell and shell trumpets, which originated in the Gulf of California in Northwest Mexico but were altered by the Hohokam, copper bells and mosaic mirrors were likely manufactured exclusively in West Mexico (McGuire and Villalpando 2007). Copper bells have been recovered

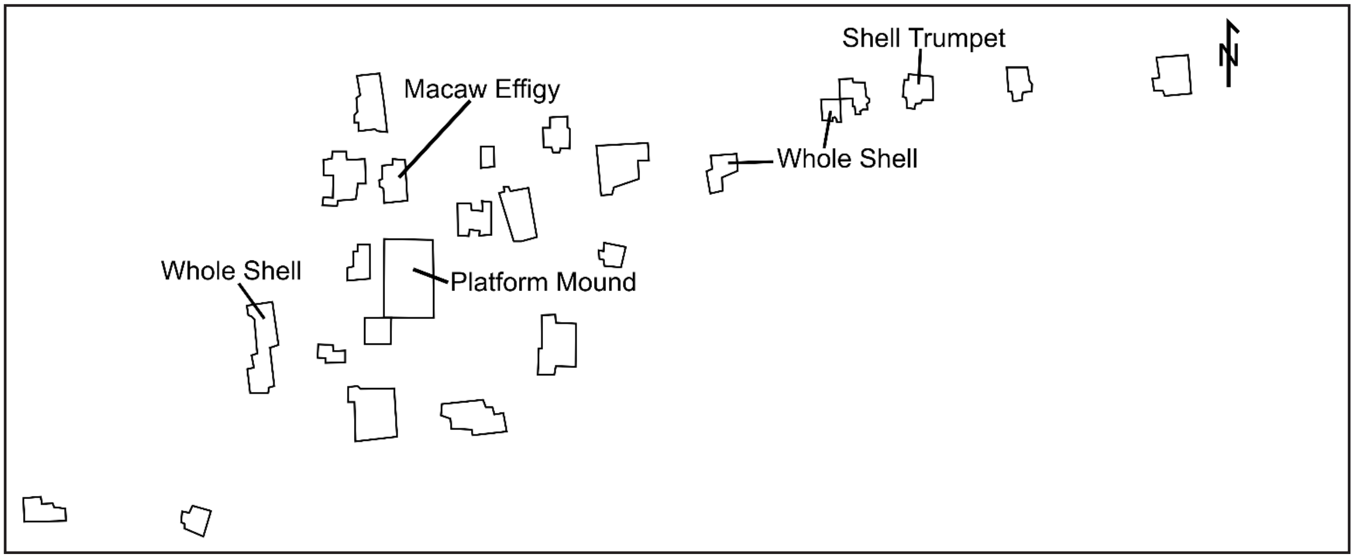

Figure 3. Location of Mesoamerican origin markers at Los Muertos. Polygons represent adobe compounds. (Redrawn from Haury 1945b:15, Figure 2)

from Los Hornos within the boundaries of the study area and Pueblo del Monte, Pueblo Grande, La Ciudad, and Las Colinas elsewhere along the lower Salt River. According to Richard Nelson (1981:Table 58), these bells were found in Classic Period contexts. A mosaic mirror found within the boundary of my study area was from an unknown context in a cave (Bell Butte of the Double Buttes; Mitalsky 1931:102-103).[2] Given the number of Mesoamerican interaction markers documented from Los Muertos, it is reasonable to assume that at least copper bells should have been found at Los Muertos, if they continued to be manufactured or hold ceremonial importance. The absence of copper bells at Los Muertos, however, hints at an explanation. The residents of Los Muertos had little to no interaction with Northwest Mexican groups to obtain items from West Mexico.

Despite the social barriers the Hohokam erected during the Classic Period, it is improbable that Los Muertos' residents did not form relationships with Northwest Mexican groups in shell collection areas, either through time spent during collection expeditions or through exchanges with those societies to obtain shell. Instead, the relationship between Los Muertos and groups to the south may have produced an ephemeral artifactual record, making it difficult to identify in the archaeological record. In this scenario, the absence of copper bells instead may have resulted from declined relationships between Northwest and West Mexico that facilitated the movement of items from West Mexico to the Hohokam region. There is no indication that comparable declines occurred between the Hohokam and peoples of Northwest Mexico, based on shell use during the Classic Period. Further, the absence of copper bells at Los Muertos may indicate that they were not central to Hohokam ritualism by the late Classic Period, since other connections were not established to acquire those items.

The question that stands is what kind of relationships did residents of Los Muertos have with groups to the south? Whole marine shell and the shell trumpet imply that relationships were strong enough to allow for their continued importation from Northwest Mexico. I therefore argued that the Mesoamerican interaction markers are more telling of the Los Muertos Hohokam than their relationships to the south. Each marker type that manifested at Los Muertos had a strong element of localness. The ideas or raw materials may have come from the south, but they were altered according to Hohokam cultural standards practiced at Los Muertos. The markers were therefore molded to reflect the Hohokam, rather than distant places.

DISCUSSION

The research question that guided this study was: were relations that the Hohokam had with groups to the south, especially Northwest Mexico, centered on focal villages, or did the interactions cross-cut irrigation system boundaries, as expected for linear communities, south of the lower Salt River? As I discussed, the relationships indicated by Mesoamerican interaction markers were likely among the Hohokam and Northwest Mexico, rather than Mesoamerica. Abbott and colleagues (Abbott et al. 2006) previously found that plain ware pottery types were more diverse among settlements on Canal System 7 than expected if a focal village had structured exchange patterns of the system's smaller member settlements. Those study results led to the hypothesis that similar exchange patterns may also manifest elsewhere in the Hohokam artifact assemblage. It was therefore expected that if relationships between the Hohokam and societies to the south followed the linear communities model, then the presence of Mesoamerican interaction markers would differ among the settlements.

The strongest lines of evidence discussed above were marine shell species variability and the distribution of external origin markers at Los Muertos. The marine shell species variability of a farmstead and a hamlet was found to be equal to or greater than most of the sampled villages (Los Hornos and Mesa Grande). Referencing the results of past shell exchange studies (Bayman 1996), the shell assemblages from sites south of the lower Salt River studied here better align with the idea that residents of each settlement acquired shell through many relationships that were not necessarily the same kinds of relationships as found at the largest villages. Marine shell species distribution patterns at the study sites are therefore better explained by expectations for linear communities rather than focal villages.

Examining Mesoamerican interaction markers at the site level revealed a lack of marker aggregation at Los Muertos. External origin markers were found to occur at more than one location, rather than clustered (e.g., at the platform mound). Further, the shell trumpet was recovered from one of the most eastern residential compounds at Los Muertos. The marker dispersal patterns across Los Muertos does not fit well with the focal village model, because it would be expected that if platform mound elites used the markers to legitimize their power through distant items, then such items would be at the platform mound. The location of the shell trumpet, therefore, does not support the focal village model.

The uniting aspect of previous studies of the relationships among Southwestern groups and cultures to the south was the belief that the interaction markers were meaningful because they represented Mesoamerica. Later models did acknowledge that some individuals used the Mesoamerican items to display social importance (e.g., Crown et al. 2015), as in the case of elite power legitimization (e.g., Gilman et al. 2014), but researchers continued to characterize southern items as esteemed by Southwestern societies because they were pieces of Mesoamerica.

I contend that equating southern items to Mesoamerica is faulty for the Hohokam that resided on the south side of the lower Salt River. The indicators either originated in Northwest or West Mexico, or were altered by the Hohokam. Careful review of the contexts that the markers were recovered from signaled that they were a part of local cultural manifestations, rather than a local variant of Mesoamerican ideology (McGuire 2011).

My repudiation of utilizing Mesoamerican interaction markers as artifactual evidence for relationships between Mesoamerica and the Hohokam south of the lower Salt River is not a condemnation of the study of southern social connections. As I discussed, the Hohokam formed and maintained relations with groups to the south. Although artifactually ephemeral, the southern connections plausibly took the form of relationships between the Hohokam and Northwest Mexico. The Hohokam south of the lower Salt River did not foster relationships with far off Mesoamerica, but rather, socially interacted with Northwestern Mexican groups in the same interaction sphere, providing networks through which items from West Mexico could be acquired. The term Mesoamerican interaction marker, therefore, does not accurately describe the relationships between south of the lower Salt River and southern groups. Instead, each marker is a line of evidence for interaction to be evaluated contextually. Perhaps, a more appropriate term for the indicators of relationships between the Hohokam and groups to the south, is Northwest/Southwest interaction markers, following the shift in focus suggested by McGuire (2011; McGuire and Villalpando 2007). The term Mesoamerican interaction marker should instead be reserved for studies of documented relationships among societies in the Mesoamerican core and areas beyond.

As a concluding thought, I pose the following questions. What do southern connections mean in the context of the Southwest? The question's focus is shifted from the amorphous whole to particular areas in the Southwest, which is something researchers have begun to acknowledge with the study of relationships with West Mexico and the Gulf Coast. Do Northwest/Southwest interaction markers in other sub-regional areas (e.g., Tucson Basin and northern Mimbres) appear to be present because they may have held importance due to the southern ideology signaled through them? Or, do recovery contexts indicate that those markers may have been modeled according to local cultural structures for local needs? Future studies of Northwest Mexican and Southwestern relationships therefore need to interrogate what southernness meant in the particular area where the interactions took place.

NOTES

[1] I placed tripod vessels into the local development Mesoamerican interaction marker category, because the vessel form appears during the Colonial Period and persists through the Hohokam cultural sequence (e.g., Chenault 2020:102–103; Haury 1976:Figures 12.15, 12.26). However, as insightfully observed by Paul Fish (personal communication 2020), Hohokam tripod vessels hold strong stylistic similarities with those type of vessels found in West Mexico, as well as other artifact types (e.g., shell jewelry, pinched-face figurines, and molded spindle whorls; McGuire and Villalpando 2007:59). Tripod vessels recovered from the Pueblo Grande platform mound in the 1930s demonstrate the presence of stylistic variation in the legs of Hohokam tripod vessels (compare Chenault 2020:Figures 5.10 and 5.11). Therefore, an avenue for future research is defining Hohokam tripod leg types, their chronological sequence, and spatial distribution. Characterizing variation in Hohokam tripod vessels will provide another line of evidence for studying the relationships among the Hohokam and societies to the south.

[2] Although beyond the scope of this article, Gallaga (2014:290) found that the number of mosaic mirrors recovered from Snaketown (n = 52) far exceeded expectations. The quantity of mirrors at Snaketown was significantly greater than all sites outside the Basin of Mexico, except for Teotihuacan and Zaculeu (n = 50+), and Nebaj in Guatemala (n = 212). Mirror abundance at Snaketown and absence at Los Muertos raises questions about the place of mirrors in Hohokam ritual. If mirrors were central to Hohokam ceremonial activity through time, then mirrors would be expected at Los Muertos. Although Haury (1976) noted a Classic Period adobe compound at Snaketown, the settlement ceased to be a village by the end of the Sedentary Period. Conversely, the main occupation of Los Muertos was the late Classic Period (Caseldine 2020). The absence of mirrors at Los Muertos, therefore, may signal that they were a part of the suite of pre-Classic cultural items that declined during the collapse of the ballcourt and marketplace systems, ca. 1070 (e.g., Abbott 2010).

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FINDING THE RIGHT TIME: THE PRE-CLASSIC ABANDONMENT OF THE LOWER VERDE VALLEY

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Stephen Germick

Analysis of ceramic data from the Hohokam Northern Periphery is used to reconstruct a chronological sequence for the collapse and abandonment of the pre-Classic Lower Verde Valley (LVV) settlement system. The method of relative dating included the seriation of LVV site sherd counts recovered from residential contexts, sorted according to the basic pottery ware types. This was compared to a seriation of ceramic data compiled from sites found throughout the Phoenix Basin Area (PBA). The patterns of Hohokam buff ware production/procurement derived from these data sets suggest the abandonment of LVV occurred soon after buff ware production peaked and rapidly delined. This appears to coincide with a process whereby Santa Cruz Red-on-buff was replaced by Sacaton Red-on-buff as the principal buff ware type. To date this process, we rely on the chronology based on the revision of Sacaton Red-on-buff and cross-referenced with tree-ring dated pottery types found at sites throughout the Lower Verde Area (LVA). The results of our study indicate the LVV settlement system collapsed and the area was effectively abandoned between AD 1000 and 1050, approximately 100 to 150 years earlier than previously assumed. Causality and the implications of our findings for the LVV, as part of the Northern Periphery, and corresponding Hohokam Core Area are discussed.

PAST AS PROLOGUE

The Lower Verde Area (LVA) has been the focus of archaeological investigation for more than 100 years. This spans the pioneering efforts of Mindeleff (1896), Fewkes (1913), and Gladwin (Gladwin and Gladwin 1930) through the more recent investigations done by Wilcox (2007) and Abbott and Spielman (2014). From this work and the endeavor of others, the prehistoric culture of the LVA has been viewed as a local expression of the Salado, Mogollon (Pilles 1976), and Sinagua (Shaffer 1972), or interpreted as a manifestation of Western Anasazi migration (Russell and Nez 2012). Others have proposed that the LVA culture, together with Salado, Sinagua, and some aspects of Mogollon represent a local expression of the Hohokam (Gladwin and Gladwin 1933; Wilcox and Shenk 1977; Wood and McAllister 1980). More recently, to rationalize cultural diversity, rapid change, and a core-periphery relationship, some now envision even the Hohokam as more of a ritual, rather than an adaptive response (Wallace 2014; Whittlesey 2007). Nevertheless, despite ambitious attempts to broach complex issues concerning cultural development, a chronological sequence for the Lower Verde Valley (LVV) has yet to be proposed.

The goal of our study was to establish a chronology for the LVA, specifically focused on the collapse and abandonment of the LVV settlement system and the surrounding area. To achieve this we seriated sherd count data recovered from LVA Late Formative, pre-Classic, and Early Classic sites. This was compared to a similar seriation of Phoenix Basin Area (PBA) sherd count data used as a baseline of Hohokam buff ware production and procurement trends. These trends were compared internally and cross-referenced with chronometric data. Herein, the rationale for our method is based on the centralized nature of Hohokam buff ware production, known trends in procurement, and the development of a widespread redistribution system, together with Wallace's (2004) revision of Haury's (1938) original Hohokam buff ware typology.

The abandonment of the LVV, one of the most fertile, well-watered, and agriculturally productive areas in central Arizona with an extensive well-developed settlement system, remains problematic. As an integral part of the LVA, this district remained largely depopulated throughout Late Prehistory and well into the

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protohistoric period. Initially, we assumed this depopulation occurred in the mid-twelfth century when a well-documented wave of abandonment swept across the Southwest. However, the results of our study indicate that for the LVV these events happened 100 to 150 years earlier. As an unintended outcome of our study and the methodology used to test the results, surprising trends in Hohokam buff ware production and procurement also became apparent. Following a brief review of the Hohokam Northern Periphery, our method and theory are outlined, the nature of the sample and results of our analysis are presented. Finally, the implications of these findings are discussed as they apply to the LVA and the Hohokam Core Area.

A REVIEW OF THE HOHOKAM NORTHERN PERIPHERY

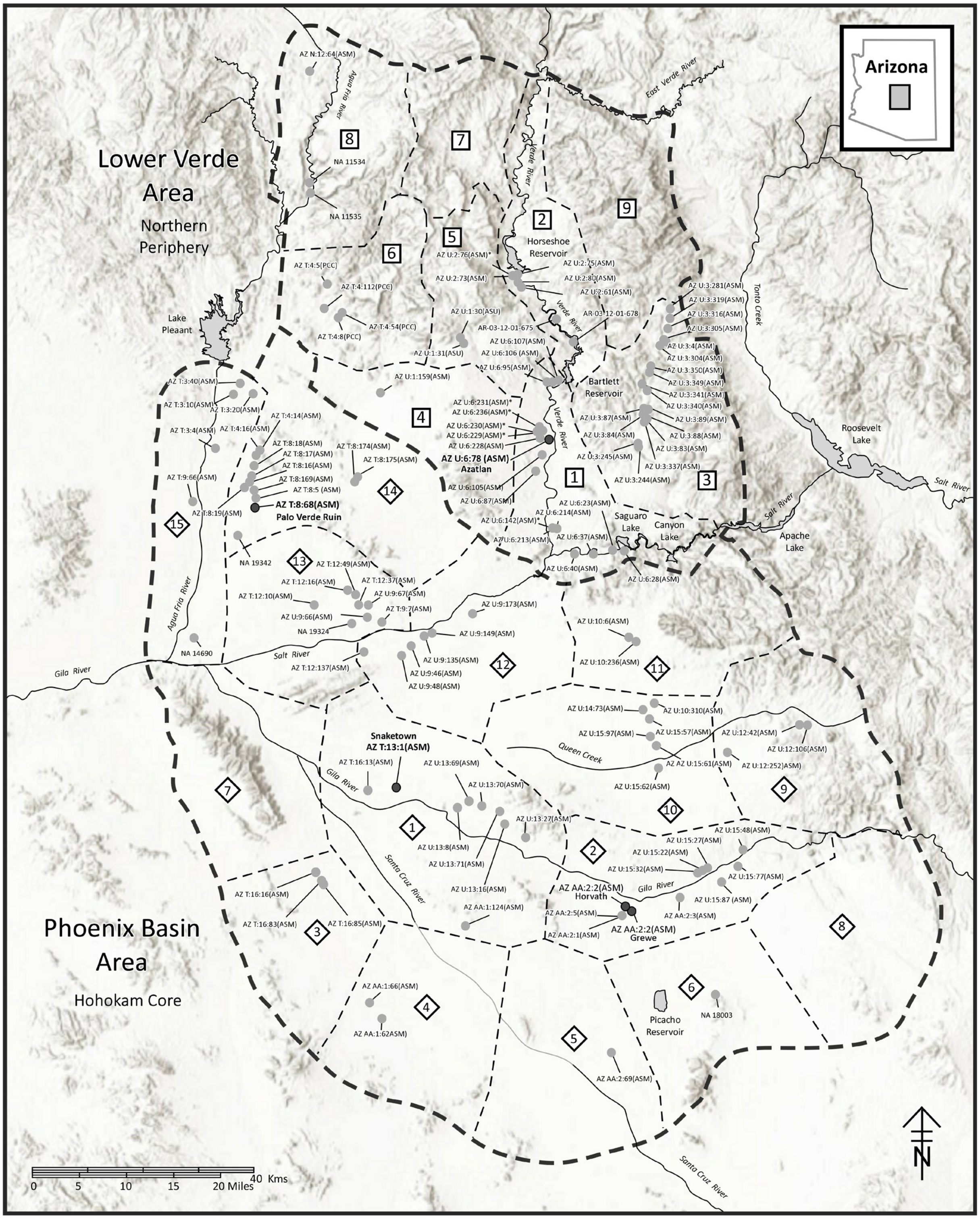
The Hohokam Core and Periphery model (Wilcox and Shenk 1977) was devised to explain the range of variability found throughout the pre-Classic Hohokam area. Under this paradigm, the Hohokam originated in a core area, the Phoenix Basin, and through a process of colonization and exchange established communities in eleven surrounding peripheries. Within this framework, the Northern Periphery (NP) was located immediately north of the Phoenix Basin. Covering a large portion of the NP, the expansive and environmentally diverse LVA is sandwiched between the Middle Verde, Payson, Tonto-Globe, Upper Agua Fria, and Bradshaw Mountains areas encompassing an area of over 2,000 miles^2/5,180 km^2 (Figure 1). Today the LVA is largely administered by the Tonto National Forest, the Bureau of Land Management's Agua Fria National Monument, and the Fort McDowell Indian Community.

For data management purposes and as a means to better track variability, the LVA area was divided into nine geographic units. These reflect subtle differences in material culture and correspond to relatively large residential site clusters and average approximately 640 km^2 in extent. Situated along the southern edge of the LVA, the LVV district, which is the focus of our study, encompasses 690 km^2. Centered on the Salt and Verde River confluence, a comprehensive survey (Canouts 1975) identified an extensive Early pre-Classic settlement system that featured a huge paramount village, Azatlan (AZ U:6:3 and U:6:78 [ASM]). This system also included ten large villages and numerous hamlets supported by canal irrigation and extensive dry farming systems. A series of small villages and hamlets extended east and west into the uplands of the Four Peaks (823 km^2) and Desert Foothills (657 km^2) districts. Villages of various sizes continue north along the Verde and Agua Fria rivers into the Horseshoe (500 km^2) and Perry Mesa (873 km^2) districts, respectively. Small residential sites also extend into the Bloody Basin (546 km^2), Camp Creek (370 km^2), New River (632 km^2), and Wilderness (790 km^2) districts (Crary 1991, 1995; Macnider and Effland 1989; Rice and Bostwick 1986; Rice and Most 1984).

An extensive system of 24 known ball courts is associated with the LVA pre-Classic settlement system (Doyel and Crary 1995a). The majority of these were situated in the LVV district with four found at Azatlan alone. Eight more were identified in the Horseshoe district, two of which were partially excavated (Deaver and Ciolek-Torrello 1997), while three ball courts are located, each in the Desert Foothills and Four Peaks districts. The LVV pre-Classic settlement system is both extensive and impressive in scale and complexity and in many respects arguably second only to that found in the Hohokam Core. Nevertheless, nearly all of the sites south of the Horseshoe Reservoir were abandoned along with large portions of the Phoenix Basin, totaling an area of nearly 3470 km^2. Based on the latest known chronologically diagnostic decorated pottery types these abandonments occurred in the Late pre-Classic period. Yet the question remains precisely when and how this event or process occurred.

THEORY AND METHODOLOGY

In theory, our study builds upon four developments that have significantly advanced our understanding of Hohokam chronology as well as ceramic production and exchange. The first is the sourcing of ceramic clays which indicates pre-Classic Hohokam buff ware production was primarily centered at a small number of villages situated in the general vicinity of Snaketown (Abbott et al. 2007a). The second is the procurement and widespread redistribution of buff ware due to the emergence of a nascent market economy tied to the Hohokam ballcourt system proposed by Abbott et al. (2007b). The third is Henderson's (1987, 2001) observation concerning consistent trends in Hohokam Buff ware production over time. The fourth development is Wallace's (2001, 2004) revision of Haury's (1938) Hohokam buff ware typology which identified three rapid changes in the design and layout of Sacaton Red-on-buff. Using these criteria we propose that resource availability, the centralized nature of the pre-Classic Hohokam craft industry, together with a nascent market economy linked to ball courts resulted in chronologically discrete production and procurement trends represented by the percentage of buff ware found within a given residential context. By extension, these trends can also be used to sequence an occupation in relative terms.



ASM Arizona State Museum ASU Arizona State University PCC Prescott Community College NA Museum of Northern Arizona AR- Archaeological Resources (Tonto National Forest)

Phoenix Basin Area Districts

1 GRIC
2 Florence
3 Ak Chin
4 Santa Rosa Wash
5 Santa Cruz Flats
6 Picacho
7 Estella
8 El Bajada
9 Picketpost
10 Queen Creek
11 Desert Wells
12 East Metro
13 West Metro
14 North Metro
15 Lower Agua Fria

Lower Verde Area Districts

1 Lower Verde Valley
2 Horseshoe
3 Four Peaks
4 Desert Foothills
5 Camp Creek
6 New River
7 Bloody Basin
8 Perry Mesa
9 The Wilderness

Figure 1. Map of central Arizona showing the Lower Verde and Phoenix Basin Areas with the sites mentioned in the study.

Our methodology used sherd count data recovered from sites scattered throughout the LVA and PBA to form individual samples that compare the percentage of basic pottery types classified as Hohokam buff, plain, red, and other wares. These were seriated as sequences and grouped according to provenance from the individual pithouse, locus, site, district, and on to the larger archaeological area. Herein, placement of individual samples within a sequence was governed primarily by the percentage of buff ware and the principal diagnostic buff ware type, unless stratigraphy indicated otherwise. The rationale for this protocol was twofold, first to map general trends in the volume of buff ware production/procurement over time, and second, to identify the principal buff ware type associated with the abandonment of the LVV and surrounding areas. As inferred by Henderson (2001), trends represent distributional trajectories in the increased or decreased frequency of buff ware that can be associated with principal decorated types. Accordingly, when compared to other types, buff ware percentages would be low in the Late Formative and Early pre-Classic period, peak around the transition from Early to the Late pre-Classic with moderate to high levels and decline to very low levels in the Late pre-Classic and Early Classic periods. It was assumed that until the abandonment of the LVV, the volume of procurement was governed chiefly by the volume of production in the PBA. Indeed, the sherd count data appears to bear this out (see Crary and Germick 2019). Red ware was present throughout much of the Late Formative and pre-Classic periods increasing in frequency by the late eleventh century (Haury 1938, 1976), and when appropriate was also used to help sequence individual samples.

After the various samples were sequenced, the trends and principal buff ware types associated with the abandonment of the LVV were identified. By extension, this also enabled the chronological placement of trends that occurred before, during, and after the LVV abandonment. Here we focused on the ceramic cross-reference of tree-ring dated northern decorated White ware associated with the principal diagnostic buff ware types, together with Wallace's (2004) four-tiered revision of Sacaton Red-on-buff. When applicable, we also compared and contrasted our findings with the analysis of the Palo Verde Ruin (Abbott 2002), Las Colinas (Abbott 2007b), and Veres (Marshall 2001; Smith 2001) buff ware assemblages.

NATURE OF THE SAMPLE

The sample used in our study consisted of sherd count data recovered from archaeological sites dispersed across much of LVA and PBA. This information was taken from literary sources and a reanalysis of collections was not performed. Nevertheless, amassing the sherd count data was often challenging given disparate report formats and analytical protocols. Difficulties also arose when attempting to access certain literature due to policy, availability, and circumstances. Several reports simply lacked the basic level of information required for our study. Although the vast majority of this information was the result of data recovery projects, a small portion was derived from archaeological surveys. To provide the most relevant assessment of ceramic trends, pithouse features were used as the basic unit of analysis the rationale being that the range of activities performed in and around domestic structures would potentially provide representative artifact assemblages. Moreover, the transitory nature of pre-Classic Hohokam pithouses (Crary and Craig 2001) together with rapid post-occupational filling ensures these features are often chronologically discrete. Typically, the mix of types represent ceramics that accumulated over an average of approximately 35 years. Therefore, every effort was made to address the sherd count data as samples recovered from individual pithouses. However, several projects grouped the data either from all contexts or according to feature type. In both cases, sherd counts associated with these projects were expressed only as a single sample.

To satisfy Doran and Hodson's (1975) rules of seriation, ceramics that composed individual samples were expressed uniformly, 2) samples represented assemblages recovered from similar contests, and 3) individual samples were grouped according to locus, site, and other relevant provenances. Therefore sherd count data was classified according to basic ware types. These included Hohokam buff ware, plain, red, and other ware types. Within a given sample the various ware types were sorted with Hohokam buff ware at the top, plain ware on the bottom, while the remaining types consistently positioned between these two poles. It may be argued that the mix of ceramic types found in some samples could be skewed by post-occupational processes such as superpositioned and intrusive features. However, our study only focused on general trends in production and procurement. We also readily concede that any sequence of pithouse samples, individuals may or may not be correctly ordered, chronologically, within a given trend. Nevertheless, given the broad criteria and temporal spans used to define most trends, and the practice of relatively short-term use of residential space known as Village Drift (Darling et al. 2004; Herr and Clark 2002, centered on the eleventh-century, excesses and bias tended to be localized. Moreover, each pithouse sample represents such small temporal niches, within an extremely large yet selective overall sample, that in most cases distortions were obvious or were otherwise irrelevant.

Overall, the sherd count data was divided into two subsets. The first included data recovered from sites situated within the LVA which was used to track local Hohokam buff ware procurement trends. The second subset consisted of sherd counts from sites located within the PBA. This subset was used as a baseline of Hohokam buff ware production trends. The use of geographically discrete districts within the larger archaeological areas provided the means to discern the range of variability present in both subsets (see Figure 3 Part A 1-8). For the geographic extent of the LVA and PBA with the location of sites mentioned see Figure 1**.** Table 1 provides a breakdown of the attributes of these subsets while Crary and Germick (2019) supply the data used in the study. In theory, the ceramic production trends found in the PBA subset provided a baseline that should be mirrored in some fashion by the procurement trends found in the LVA subset. Yet, as the LVV settlement system collapsed, the LVA procurement trends should significantly diverge from the PBA production trends.

Due to the limited goals of our study only sherd counts from sites dated to the Late Formative, pre-Classic, and Early Classic periods were used while the Late Classic period assemblages were excluded. Overall, the LVA subset included 181,905 sherds, organized as 225 individual samples from 46 sites scattered throughout seven of the nine geographic districts. The PBA subset consisted of 867,429 sherds that represent 959 individual samples from 70 sites, found in thirteen of the fifteen districts. Combined overall, data recovered from 116 sites, with 1184 samples, and slightly over a million sherds were used in the study.

In tabular form, individual samples were sequenced from left to right, with increasing levels of Hohokam buff wares dominated by Snaketown and Gila Butte Red-on-buff or a mix of Gila Butte and Santa Cruz Red-on-buff. The protocols used to sort and sequence individual and site samples, while somewhat subjective, were based on three criteria. The first follows Henderson's (2001) assessment of Hohokam buff ware production/procurement over time. According to Henderson's (2001) observations, the samples with the highest percentage of buff ware consistently proved to be dominated by Santa Cruz and Santa Cruz/Sacaton Red-on-buff. This represented the peak of buff ware production and served to center a given locus or site sequence. Consequently, samples dominated by Sacaton or Casa Grande Red-on-buff were sequenced from the center, with decreasing levels of buff ware.

The second criterion sorted samples within a sequence according to the principal buff ware type, which often corresponded to the phase assignment. The determination of the principle buff ware type was primarily based on the initial analytical assessment. As our study focused on the abandonment of the LVV, special attention was paid to Sacaton Red-on-buff. Upon review of the literature summary evaluations were made according to Wallace's (2004; also see Abbott 2007a) revisions of Haury's (1938) typology using key attributes to define Early, Middle, and Late Sacaton Red-on-buff. For example, these included line thickness and simplistic panel designs for Early Sacaton, the large floating diamond motif for Middle Sacaton 1, a sharp Gila shoulder, flared rim, and compacted lattice design for Middle Sacaton 2, and geometric elements within circular voids centered on solid triangular motifs for Late Sacaton Red-on-buff. Although not a perfect solution, descriptions, graphic representations, and published photographic examples provided in data recovery reports proved useful. However, as representative examples of Sacaton Red-on-buff were not always available in the literary sources, as a last resort, Tonto National Forest collections, and numerous previously investigated sites were revisited. Although diagnostic buff ware types were identified at several of the larger sites, we were unable to determine the presence or absence of a particular revised Sacaton type at the majority of the smaller sites.

The third criterion relied on the stratigraphic relationship of pithouses. However, there were several cases when the percentage of buff ware, dominant buff ware type, and superpositioning did not correspond to the initial phase assignment. Chronologically, these tended to occur on either side of the peak production level. In these cases, individual samples were sequenced on the appropriate side of the center, based on stratigraphy. The seriation and sequencing of the LVA sherd count data are provided in Figure 2.

RESULTS

Following the prevailing conventions concerning the transition from pre-Classic to Classic Hohokam (Clark and Abbott 2017), we initially assumed that the LVV settlement system collapsed and a large swath of territory situated between the LVA and PBA was effectively abandoned around AD 1150. However, the results of our study did not support this assumption. As Craig and Woodson (2017) aptly state, 'new interpretive models are needed.' With this in mind, our analysis of the LVA subset identified five distinct trends in Hohokam buff ware procurement. LVA Procurement Trend I was primarily associated with Gila Butte and Santa Cruz Red-on-buff. Throughout the LVA the percentage of Hohokam buff ware was low with a slight increase; ranging from 1 to 12%. Trend II was distinguished by a dramatic increase in the frequency of buff ware as procurement doubled, tripled, and in some cases more than quadrupled;

Table 1. LVA (Part B) PBA (Part B), and Total (Part C) Sherd, Sample, and Site Count Summaries

	LVA No.*	District	Sherd Count Data	Samples	Number of Sites
Part A	1	Lower Verde Valley	63,833	45	13
	2	Horseshoe	37,750	57	5
	3	Four Peaks	20,117	33	18
	4	Desert Foothills	11,051	30	1
	5	Camp Creek	20,559	13	2
	6	New River	12,823	15	4
	7	Bloody Basin	-	-	-
	8	Perry Mesa	15,772	32	3
	9	The Wilderness	-	-	-
	Subtotal		181,905	225	46
	PBA No.†	District	Sherd Count Data	Samples	Number of Sites
Part B	1	GRIC	5,535	50	9
	2	Florence	240,129	184	11
	3	Ak Chin	24,761	13	3
	4	Santa Rosa Wash	21,078	45	2
	5	Santa Cruz Flats	15,81	4	1
	6	Picacho	22,82	29	1
	7	Estella	-	-	-
	8	El Bajada	-	-	-
	9	Picketpost	14,205	16	3
	10	Queen Creek	67,056	14	7
	11	Desert Wells	28,452	31	2
	12	East Metro	74,258	125	6
	13	West Metro	236,994	335	8
	14	North Metro	71,688	84	11
	15	Lower Agua Fria	79,410	19	6
	Subtotal		867,429	959	70
Part C	***Grand Total***		104,9334	1,184	116

*LVA Lower Verde Area; †PBA Phoenix Basin Area

reaching a peak of between 25 and 80%. Due to gaps in our coverage, the geographic extent of this increase is unclear. However, sherd counts from the Antler House Village site, situated in the northern portion of the Perry Mesa district and abandoned before the procurement peak, with buff ware percentages between 26 and 42 percent, suggest this increase was widespread. Trend II was also predominantly associated with Santa Cruz Red-on-buff, while Sacaton Red-on-buff was present. Based on published examples that consistently lacked the complexity and graphic reference to textile patterns, this type appears typical of Wallace's (2004) revised Early Sacaton Red-on-buff. Figure 3 shows the sequence, chronological, and geographic distribution of the production/procurement trends for the PBA and LVA based on the sherd count data.

The Trend II peak was followed by LVA Trend III characterized by a precipitous decrease in the frequency of buff ware procurement dropping to as low as 10% of a given assemblage. Again, based on published examples, the principal type appears to be Middle Sacaton 1 Red-on-buff (Wallace 2004). Interestingly, Middle Sacaton 2 Red-on-buff, as defined by Wallace (2004) was absent. The decreased volume of buff ware procurement and the limited mix of types suggest Trend III represented a short period. In contrast, LVA Trend IV can be summarized as a long-term pervasive decline with low buff ware frequencies that hovered between 7 and 1 percent of a given sample. Based on published examples, Trend IV was associated with Wallace's (2004) revised Late Sacaton Red-on-buff, while Middle Sacaton 2 Red-on-buff was not present. Another trait of this trend was the increased use of red ware which comprised between 2 and 25 percent of an assemblage. Interestingly, the sites with the highest red ware frequencies were situated in the Horseshoe and Perry Mesa districts. However, the most important aspect of Trend IV was that there was no evidence of buff ware use in the LVV or much of the Four

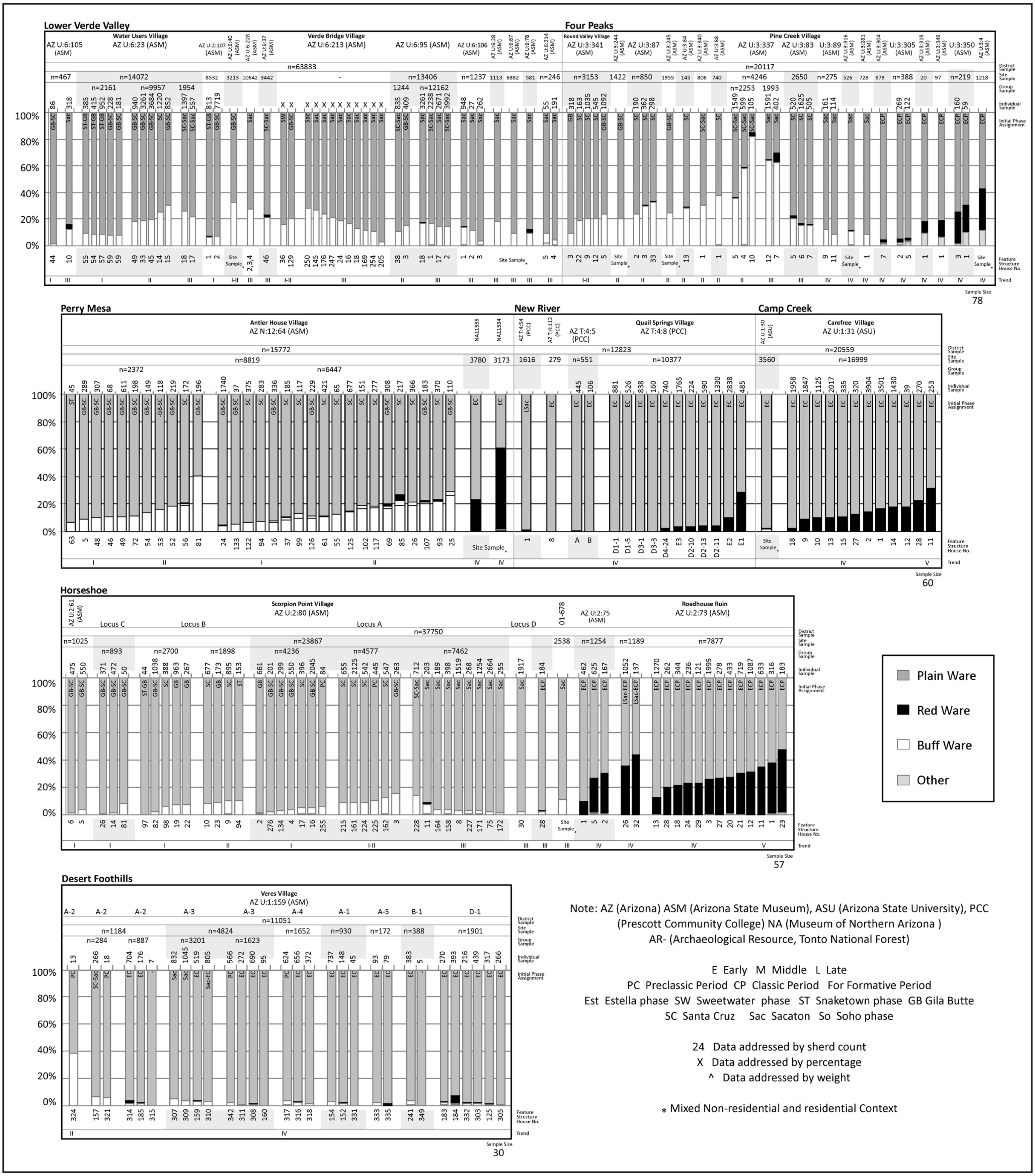


Figure 2. The LVA sherd count seriation and sample sequence.

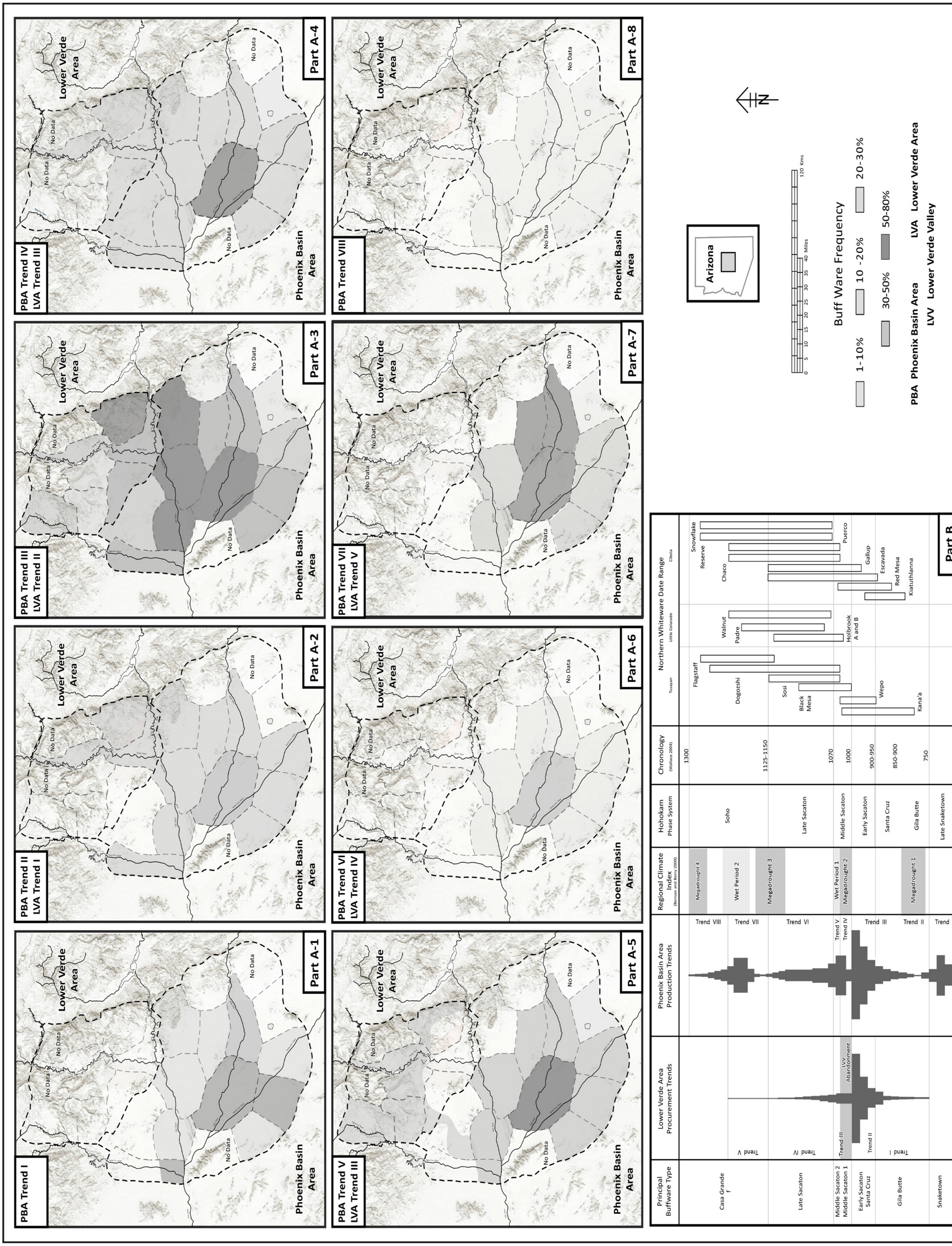


Figure 3. Part A 1-8) Hohokam Buff ware production/procurement trends, Part B) cross-reference of principal Buff ware type, production and procurement trends, regional climatic index, Hohokam phase sequence, chronology, and decorated northern Whiteware date ranges.

Peaks and Desert Foothills districts. This also occurred in the southern portion of the Horseshoe district as well. This suggests that the LVV and surrounding areas were effectively abandoned before the use of Late Sacaton Red-on buff. Finally, LVA Trend V represented the continued drop in the procurement of buff ware falling below 4 percent leading to its complete absence. Although extremely limited in frequency, the only type associated with this trend was Casa Grande Red-on-buff. This trend was also characterized by a significant increase in red ware ranging from 45 to 60 percent. Moreover, in the Four Peaks district, corrugated pottery, particularly Salado Red, made up approximately 10% of the ceramic assemblage with trace amounts of corrugated pottery also found at sites in the Horseshoe district.

Analysis of the PBA subset found eight discrete production trends (see Figure 3). Production Trend I was associated with Red-on-grey and early buff ware pottery, with Sweetwater Red-on-gray and Snaketown Red-on-buff as the principal decorated types. Quite unexpectedly, the frequency of these Late Formative buff ware types seems to have been as high as 30% in several of the PBA districts. This is supported by Haury's (1976) test excavations at Snaketown of a large trashmound (see Crary and Germick 2019) where Snaketown Red-on-buff ranged from 30 to nearly 50 percent of the ceramic assemblage. In contrast, Trend II represented a significant drop in production to around 1%. From this point, production appears to have increased to around 15%. However, at the site of Snaketown, the frequency of buff ware appears to have remained high, at around 32%. Production Trend II was primarily associated with Gila Butte and Santa Cruz Red-on-buff. The most common buff ware types associated with Trend III was Santa Cruz and Sacaton Red-on-buff. However, based on published depictions together with the use of the provisional Santa Cruz-Sacaton Red-on-buff, this type appears to represent Early Sacaton Red-on-buff as defined by Wallace (2004). Trend III also represented the all-time peak for Hohokam buff ware production reaching percentages that ranged from 30 and 78 percent through all of the PBA districts with coverage.

PBA Trend IV was characterized by decreased production, with frequencies throughout most of the PBA dropping as low as 7%. The exception appears to be the Gila River Indian Community (GRIC) district where buff ware use did not fall below 20%. Based on Wallace's (2004) analysis of Snaketown pottery and other published examples Trend IV was primarily associated with Middle Sacaton 1 Red-on-buff. Although rather short-lived, this trend was followed by the equally short PBA Trend V, which appears to represent an abrupt production rebound. The highest frequencies were found primarily at sites in the GRIC district. For example, Haury (1976) found buff ware frequencies in trashmounds at Snaketown associated with Middle Sacaton Red-on-buff (see Wallace 2004), which consistently ranged between 35 and 50 percent. Likewise, at the Maricopa Road site, Buff ware primarily associated with Middle Sacaton Red-on-buff reached frequencies of 70%. Wallace's (2004) analysis has revised this as Middle Sacaton 2 Red-on-buff. However, in outlying areas, such as the Picket Post, Lower Agua Fria, and North Metro districts, buff ware procurement declined and remained low.

PBA Trend VI can be characterized as a prolonged decline in buff ware production with frequencies falling from 25 to around 2 percent throughout the PBA. Even in the GRIC district, buff ware frequencies dropped to significantly low levels. Based on descriptions and published examples, the principal buff ware type was Late Sacaton Red-on-buff (see Wallace 2004). Another attribute of this trend was that as buff ware frequency decreased, red ware appeared and its use increased to around 4%. However, the exception to this rule was the Picketpost district, where red ware frequency was between 10 and 52 percent. The PBA production Trend VII represented an unexpected increase in buff ware production from 5 to as much as 30 percent although this was largely restricted to sites located in the GRIC, Florence, and Queen Creek districts. Based on survey data, buff ware production in the GRIC district may have rebounded from 5 to as much as 65 percent. In other PBA districts frequencies remained below 8%. As Late Sacaton Red-on-buff appears to have been completely replaced, production Trend VII was associated with Casa Grande Red-on-buff with a slight increase in red ware use to nearly 7%. Redware use in the Florence and Brady Wash districts increased considerably to between 15 and 35 percent. Finally, PBA production Trend VIII represents a progressive decline in buff ware use associated with Casa Grande Red-on-buff with frequencies falling below 5% as Redware use increased to between 10 and 12% in the West Metro District.

Several observations can be made based on our results. First, the sequence of trends found in the PBA subset indicates that the production of buff ware fluctuated, reflecting shifts in the volume of buff ware being made, with alternating high to low outputs. Herein, four trends represent increases, each followed by a significant decrease in production. Second, the general procurement trends identified in the LVA subset did not mirror the overall PBA pattern of production. Instead, we find a simple trend-line from low and moderate, to peak production, followed by rapid decline and eventually termination. Third, in both subsets, each trend was associated with a principal, if not different buff ware type. Therefore, the buff ware frequencies associated with each trend can be cross-referenced from one subset to the other by matching the corresponding principal buff ware types. In this manner, PBA production Trends II and III are roughly analogous to the LVA procurement Trends I and II, respectively. Furthermore, the PBA production Trend VI and VII coincides with the LVA procurement Trend IV and V, and PBA production Trend IV and V chronologically correspond to LVA procurement Trend III. However, there was no correlation between PBA production Trends I and VIII and any of the LVA procurement trends. The inability to match several PBA and LVA trends appears to be due to episodes of low or minimal interaction. More importantly, due to the presence of Middle Sacaton 1 and the absence of Middle Sacaton 2 Red-on-buff, as well as Black Mesa Black-on-white, the LVV abandonment likely occurred during the LVA procurement Trend III, which chronological corresponds to the PBA production Trend IV. As will be discussed below the most convincing evidence for this conclusion is AZ U:3:87 (ASM) and AZ U:3:337(ASM) in the Four Peaks district and AZ U:6:37(ASM), AZ U:6:78 (ASM), AZ U:6:213 (ASM), and AZ U:6:231(ASM) (Table 2, see also Figure 2) with AZ U:6:228(ASM) in the LVV district where complete floor assemblages included several Middle Sacaton 1 Red-on-buff vessels found in two burned pithouses (Figure 4, see also Table 2).

Ceramic Cross-Reference

Critical to establishing the chronology for the LVV abandonment is the ceramic cross-reference of Early, Middle, and Late Sacaton Red-on-buff with LVA procurement trends. Based on Haury's (1938) initial typology, Dean (1991) used a wide-range of radiocarbon data to date Sacaton Red-on-buff between AD 950 and 1150. In the late 1990s, Wallace (2004) began outlining the attributes for the Early, Middle, and Late variants of Sacaton Red-on-buff using a design analysis of buff ware recovered from Snaketown, Los Hornos, Los Solares/La Ciudad, Las Canopas, and Los Guanacos. Concurrently, Abbott (2002; Abbott et al. 2007b) used the percentage of decorated pottery, frequency of phyllite-tempered red ware, and the percentage of the brown paste buff ware variant together with the presence of cross-referenced tree-ring dated northern white ware, to test Wallace's (2004) revision. Abbott (2007b) further bolstered support for Wallace's (2004) revisions by comparing the percentage of buff ware recovered from 68 dated features at Las Colinas. From these studies, Early Sacaton was dated at AD 950 to 1020, Middle Sacaton from AD 1020 to 1070, and Late Sacaton Red-on-buff at between AD 1070 and 1150.

Applying this chronology to the New River Dam Project (Doyel and Elson 1985a) and the Palo Verde Ruin (Hackbarth et al. 2007), Abbott et al. (2007b) were able to reconstruct the settlement history for the Lower New River area, which is situated in our North Metro district. Accordingly, from the middle of the ninth through the tenth centuries numerous small residential sites were occupied along the west side of New River. Around AD 1000 these settlements were abandoned and the large formal Palo Verde Ruin Village was established on the east side of New River. However, by AD 1070 this settlement was also abandoned (Hackbarth et al. 2007) while much of the North Metro district was also depopulated at this time. Citing Doyel's (1993, 2000) study of intrusive tree-ring dated decorated northern white ware pottery at Snaketown, Abbott et al. (2007b) also noted a major disruption of the Hohokam ballcourt system that may have culminated in the abandonment of Snaketown around AD 1075.

Absolute Dating

We addressed the issues of absolute dating as it applied specifically to the LVA sherd count data with a detailed review of the buff ware and northern white ware types. Table 2 provides a list of the decorated sherd count data from the LVA sites used in our study according to type. To provide greater overall depth this list also includes LVA sites not used in our study. Although discernible pottery types made up only a small fraction of the decorated pottery, the data indicates three temporally discrete groups of sites. The first consists of sites with buff ware assemblages that included Sweetwater through Early Sacaton Red-on-buff. These sites were associated with LVA Trend I and II and included AZ U:6:23, U:6:28, U:6:107, and U:6:40 (ASM) in the LVV district; as well as AZ U:2:61, U:2:80, N:12:64, U:3:245 U:3:281, U:3:340, U:3:341, U:3:84, U:3:88, and U:3:244 (ASM) in the Horseshoe, Perry Mesa, and Four Peaks districts (see Figure 1). The second group of sites was associated with LVA Trends I through III and had buff ware assemblages that ended with Middle Sacaton 1 Red-on-buff. These sites include AZ U:6:37 Locus A, U:6:37 Locus B, U:6:78, U:6:142, U:6:213, U:6:228, U:6:231, U:2:80 Locus A, U:3:83, U;3:87, and U:3:337 (ASM), as well as AR-12-03-01-675 and 01-678. buff ware types characteristic of the first group of sites were common at these sites which suggest habitation of an extended period. These sites were primarily located in the LVV, Horseshoe, and Four Peaks districts. Several additional sites had similar buff ware percentages and belong within the second group, however, it was not possible to verify the presence of Middle Sacaton 1 Red-on-buff. Although Middle Sacaton 2 or Late Sacaton Red-on-buff were not identified at AZ U:3:83(ASM), an extended inhumation burial in a trashmound suggests this site continued to be occupied. Another extended burial at AZ U:3:341(ASM) Locus A also suggests a slightly later occupation restricted to the adjacent Locus C.

Table 2. LVA Decorated Sherd Count Data

Site No.	LVA Districts																	
	Hohokam Buffware					Tusayan Whiteware						Little Colorado Whiteware			Cibola Whiteware			
	Sweetwater Snaketown Gila Butte Santa Cruz	Santa Cruz Sacaton	Sacaton	Casa Grande	Indeterminate	Kana'a	Black Mesa	Wepo	Sosi	Flagstaff	Indeterminate	Walnut	Holbrook	Indeterminate	Red Mesa	Kiatuthlanna	Indeterminate	Total
Lower Verde Valley, LVA –01																		
AZ U:6:40(ASM)	17	16	–	–	1,000	–	–	–	–	–	–	–	–	–	–	–	–	1,033
AZ U:6:23(ASM)	646	131	27 (ES)	–	525	–	–	–	–	–	–	–	–	–	–	–	–	1,329
AZ U:6:28(ASM)	5	10	3 (ES)	–	182	–	–	–	–	–	–	–	–	–	–	–	–	200
AZ U:6:95(ASM)	347	29	85 (ES)	–	2,729	–	–	–	–	–	–	–	–	–	–	–	–	3,190
AZ U:6:107(ASM)	136	13	9 (ES)	–	698	–	–	–	–	–	2	–	–	–	–	–	–	858
AZ U:6:37(ASM) locus A	261	–	243 (ES, MS 1)	–	2,079	–	–	–	–	–	3	–	–	–	–	–	–	2,586
AZ U:6:37(ASM) locus B	81	–	112 (ES, MS 1)	–	794	–	–	–	–	–	–	–	–	–	–	–	–	987
AZ U:6:78(ASM)	28	30	4 (ES, MS 1)	–	588	–	–	–	–	–		–	–	–	–	–	–	650
AZ U:6:142(ASM)*	2	3	36 (ES, MS 1)	–	92	–	–	–	–	–	1	–	–	–	–	–	1	135
AZ U:6:213(ASM)	232	25	348 (ES, MS 1)	–	2,729	5	–	–	–	–	–	–	–	2	–	–	–	3341
AZ U:6:228(ASM)	6	5	724 (ES, MS 1)	–	2,201	–	–	–	–	–	–	–	–	–	1	–	–	2937
AZ U:6:231(ASM)	4	6	142 (ES, MS 1)	–	689	–	–	–	–	–	–	–	–	–	–	–	–	841
AZ U:6:106(ASM)	4	1	12 (Indet)	–	138	–	–	–	–	–	2	–	–	1	–	–	1	159
AZ U:6:235(ASM)*	4	4	80 (Indet)	–	109	–	–	–	–	–	–	–	–	–	–	–	–	197
AZ U:6:230(ASM)*	1	–	22 (Indet)	–	115	–	–	–	–	–	–	–	–	–	–	–	–	138
AZ U:6:87(ASM)	–	3	7 (Indet)	–	300	–	–	–	–	–	–	–	–	–	–	–	–	310
AZ U:6:214(ASM)	1	1	3 (Indet)	–	7	–	–	–	–	–	–	–	–	–	–	–	–	12
AZ U:6:105(ASM)	–	–	10 (Indet)	–	38	–	–	–	–	–	–	–	–	–	–	–	–	48
AZ U:6:229(ASM)*	–	–	6 (Indet)	–	39	–	–	–	–	–	–	–	–	–	–	–	–	45
AZ U:6:232(ASM)*	3	–	12 (Indet)	–	73	–	–	–	–	–	3	–	–	–	–	–	–	91
AZ U:6:233(ASM)*	1	–	7 (Indet)	–	71	–	–	–	–	–	–	–	–	–	–	–	–	79
AZ U:6:234(ASM)*	–	–	1 (Indet)	–	6	–	–	–	–	–	–	–	–	–	–	–	–	7
AZ U:6:236(ASM)*	–	–	12 (Indet)	–	85	–	–	–	–	–	–	–	–	–	–	–	–	97
Subtotal	**1,779**	**277**	**1,905**	**–**	**1,5287**	**5**	**–**	**–**	**–**	**–**	**11**	**–**	**–**	**3**	**1**	**–**	**2**	**19,270**

continued

Table 2. LVA Decorated Sherd Count Data

Site No.	LVA Districts																	
	Hohokam Buffware					Tusayan Whiteware						Little Colorado Whiteware			Cibola Whiteware			
	Sweetwater Snaketown Gila Butte Santa Cruz	Santa Cruz Sacaton	Sacaton	Casa Grande	Indeterminate	Kana'a	Black Mesa	Wepo	Sosi	Flagstaff	Indeterminate	Walnut	Holbrook	Indeterminate	Red Mesa	Kiatuthlanna	Indeterminate	Total
Horseshoe, LVA –02																		
AZ U:2:61(ASM)	20	–	–	–	36	–	–	–	–	–	–	–	–	–	–	–	–	56
AZ U:2:80(ASM) locus B	56	5	6 (ES)	–	234	–	–	–	–	–	–	–	–	–	–	–	–	301
AZ U:2:80(ASM) locus C	16	–	2 (ES)	–	55	–	–	–	–	–	–	–	–	–	–	–	–	73
AZ U:2:80(ASM) locus D	2	–	4 (ES)	–	35	–	–	–	–	–	–	–	–	–	–	–	–	41
AR –03 –12 –01 –678	18	12	5 (ES, MS 1)	–	154	–	–	–	–	–	–	–	–	–	–	–	–	189
AR –03 –12 –01 –675 *	–	5	5 (ES, MS 1)	–	33	–	–	–	–	–	1	–	–	–	–	–	–	44
AZ U:2:80(ASM) Locus A	144	53	23 (ES, MS 1, LS)	–	468	1	7	3	–	–	12	–	–	–	1	2	1	715
AZ U:2:75(ASM)	–	–	3 (LS)	–	4	–	–	–	–	–	–	10	–	–	–	–	–	17
AZ U:2:76(ASM)*	–	–	1 (LS)	–	1	–	–	–	3	–	3		–	–	–	–	–	7
AZ U:2:73(ASM)	1	1	2 (ES, LS)	–	5	–	–	–	–	–	1	1	–	–	–	–	–	11
Subtotal	**257**	**76**	**51**	**–**	**1,025**	**1**	**7**	**3**	**3**	**–**	**17**	**11**	**–**	**–**	**1**	**2**	**1**	**1,454**
Four Peaks, LVA –03																		
AZ U:3:281(ASM)	–	–	–	–	65	–	–	–	–	–	1	–	–	–	–	–	–	66
AZ U:3:245(ASM)	13	2	–	–	457	–	–	–	–	–	–	–	–	–	–	–	–	472
AZ U:3:340(ASM)	2	–	–	–	217	–	–	–	–	–	–	–	–	–	–	–	–	219
AZ U:3:341(ASM) locus A	140	–	–	–	731	–	–	–	–	–	2	–	–	–	–	–	–	873
AZ U:3:341(ASM) locus D	8	–	–	–	12	–	–	–	–	–	–	–	–	–	–	–	1	21
AZ U:3:84(ASM)	–	7	4 (ES)	–	36	–	–	–	–	–	–	–	–	–	–	–	–	47
AZ U:3:88(ASM)	9	45	4 (ES)	–	237	–	–	–	–	–	–	–	–	–	–	–	–	295
AZ U:3:244(ASM)	9	–	7 (ES)	–	280	–	–	–	–	–	–	–	–	–	–	–	–	296
AZ U:3:83(ASM)	6	103	92 (ES, MS 1)	–	397	–	–	–	–	–	–	–	–	–	–	–	–	598
AZ U:3:87(ASM)	11	75	52 (ES, MS 1)	–	156	–	–	–	–	–	–	–	–	–	–	–	–	294
AZ U:3:337(ASM)	172	2	221 (ES, MS 1)	–	4,051	–	–	–	–	–	1	–	–	–	1	2	4	4,454
AZ U:3:305(ASM)	–	–	3 (LS)	–	17	–	–	–	–	–	10	–	–	–	–	–	–	30
AZ U:3:316(ASM)	–	–	2 (LS)	–	54	–	–	–	–	–	–	–	–	–	–	–	–	56
AZ U:3:319(ASM)	–	–	–	–	2	–	–	–	–	–	–	–	–	–	–	–	–	2
AZ U:3:304(ASM)	–	–	–	–	6	–	–	–	–	–	–	–	1	1	–	–	2	10

continued

Table 2. LVA Decorated Sherd Count Data

Site No.	LVA Districts																	
	Hohokam Buffware					Tusayan Whiteware						Little Colorado Whiteware			Cibola Whiteware			
	Sweetwater Snaketown Gila Butte Santa Cruz	Santa Cruz Sacaton	Sacaton	Casa Grande	Indeterminate	Kana'a	Black Mesa	Wepo	Sosi	Flagstaff	Indeterminate	Walnut	Holbrook	Indeterminate	Red Mesa	Kiatuthlanna	Indeterminate	Total
AZ U:3:341(ASM) locus B	–	–	–	–	30	–	–	–	–	–	–	–	–	–	–	–	–	30
AZ U:3:349(ASM)	–	–	–	–		–	–	–	–	–	6	–	–	–	–	–	–	6
AZ U:3:350(ASM)	–	–	–	–	3	–	–	–	–	–	–	–	–	–	–	–	1	4
Subtotal	**370**	**234**	**385**	**–**	**6,751**	**–**	**–**	**–**	**–**	**–**	**20**	**–**	**1**	**1**	**1**	**2**	**8**	**7,773**
Desert Foothills, LVA –04																		
AZ U:1:159(ASM)	4	45	10 (ES –LS, CC)	13	404	–	–	–	–	4	1	4	–	2	–	–	–	487
Camp Creek, LVA –05																		
AZ U:1:30(ASU)	–	–	3	–	34	–	–	–	–	–	2	–	–	–	–	–	–	39
AZ U:1:31(ASU)	–	–		–	13	–	–	–	–	–	1	–	–	6	–	–	–	20
Subtotal	–	–	3	–	47	–	–	–	–	–	3	–	–	8	–	–	–	59
New River, LVA –06																		
AZ T:4:5(PCC)	–	–		–	1	–	–	–	–	–	–	–	–	–	–	–	–	1
AZ T:4:8(PCC)	–	–		–	8	–	–	–	–	–	2	–	–	–	–	–	–	10
AZ T:4:54(PCC)	–	–	2	–	8	–	–	–	–	–	2	–	–	–	–	–	–	12
Subtotal	–	–	2	–	17	–	–	–	–	–	4	–	–	–	–	–	–	23
Perry Mesa, LVA –08																		
N:12:64(ASM) Area A	488	–	2 (ES)	–	498	–	–	1	–	–	3	–	–	–	–	–	–	992
N:12:64(ASM) Area B	1,110	–	1 (ES)	–	773	12	5	–	–	–	55	–	–	–	–	–	–	1,956
NA 11534	–	–	3	–	11	–	–	–	–	–	41	–	–	–	–	–	–	55
NA 11535	–	–	2	–	12	–	–	–	–	–	13	–	–	–	–	–	–	27
Subtotal	1,598	–	8	–	1,294	12	5	1	–	–	112	–	–	–	–	–	–	3,030
Grand Total	**4,008**	**632**	**2,351**	**13**	**24,788**	**18**	**12**	**4**	**3**	**4**	**163**	**15**	**1**	**14**	**3**	**4**	**11**	**32,096**

Assemblage ending by AD 1000
Assemblage ending by AD 1050
Assemblage ending by AD 1000 or 1050
Assemblage before AD 1000 and after AD 1050
Assemblage beginning after AD 1000
Assemblage ending before AD 1000 and beginning after AD 1100 until 1250
AR = Archaeological Resource (Tonto National Forest)
Assemblage beginning after AD 1050 and ending by 1300
ES = Early Sacaton MS 1 = Middle Sacaton 1 MS 2 = Middle Sacaton 2 LS = Late Sacaton CC = Casa Grande
ASM = Arizona State Museum ASU = Arizona State University PCC = Prescott Community College NA = Museum of Northern Arizona

* Site/Locus not included in current study (type present)
See Crary and Germick (2019) for sherd count data references

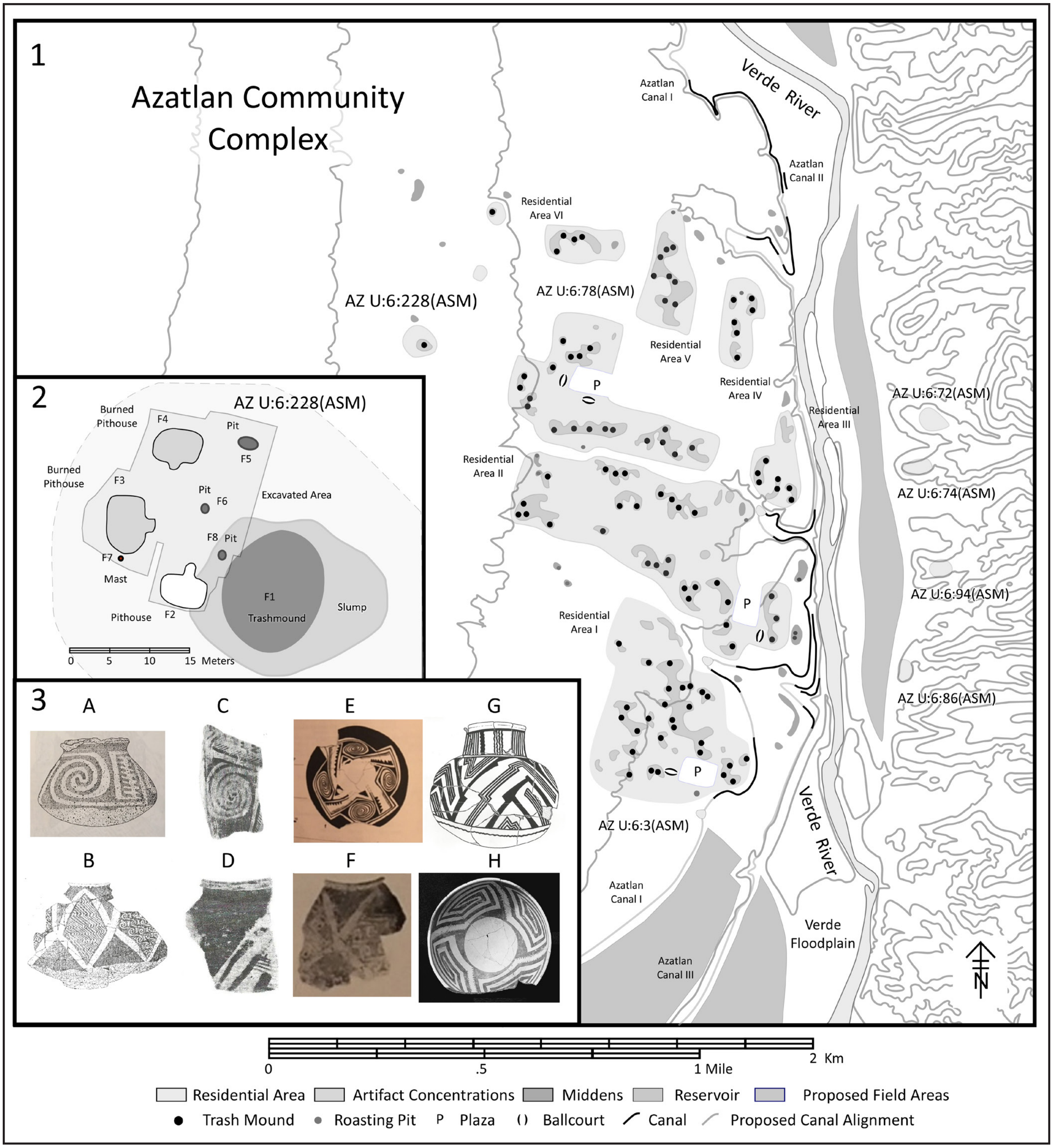


Figure 4. 1) Map of the Azatlan Village complex, 2) map of AZ U:6:228(ASM), 3) examples of Middle Sacaton 1 Red-on-buff, A and B] from Feature 3 at AZ U:6:228(ASM), C and D] from AZ U:6:213(ASM), E and F] from AZ U:3:337(ASM), and G and H] from AZ U:1:159(ASM) and AZ U:2:80(ASM), respectively.

The decorated assemblages associated with the third group of sites consisted of Late Sacaton and Casa Grande Red-on-buff and/or northern white wares exclusively. These were associated with LVA Trend IV and V and were found at AZ T:4:5, T:4:8, T:4:54 (PCC); AZ U:1:30, U:1:31 (ASU): AZ U:2:75, U:2:76, U:3:304, U:3:305, U:3:316, U:3:319, U:3:341 Locus B, U:3:349, U:3:350 (ASM); NA 11534, and NA 11535 in the New River, Camp Creek, Four Peaks, Horseshoe, and Perry Mesa districts. None of the sites in the third group were located in the LVV district. Only two sites had buff ware assemblages with types found in the first and third groups without Middle Sacaton 1. These assemblages were associated with LVA Trends I, II, IV, and V and include AZ U:2:73 (ASM) and AZ U:1:159(ASM) (Smith 2001) in the Horseshoe and Desert Foothills districts, respectively. Finally, only one site had a buff ware assemblage with types found in all three groups. This was AZ U:2:80 (ASM) Locus A, in the Horseshoe district, which was also located outside of the area of the LVV abandonment.

The pottery types in the three assemblage groups listed above were also cross-referenced with the associated northern white wares found in Table 2. Again, the typed white wares represent only a very small fraction of the overall assemblage. These tree-ring dated white wares fall into two temporal and regional data sets. The first dates from the mid-ninth century to around AD 1000 and includes Kana'a and Wepo (often classified as an early form of Black Mesa) Black-on-white, which are Tusayan white wares together with Kiauthlanna and Red Mesa Black-on-whites, which are Chaco-Cibola White wares. The second set consists of Black Mesa, Sosi, and Flagstaff Black-on-white, as Tusayan White wares and Holbrook A and B with Walnut Black-on-white, which is a Little Colorado White ware. Superficially, the first set is dated before AD 1000 (Downum 1988; Hayes-Gilpin and Hartsveldt 1998), while the second set after AD 1050 (Downum and Sullivan 1990; Garcia 2004; Sullivan et al. 1995), with only the Cibola Red Mesa and the Tusayan Black Mesa Black-on-white co-occurring between AD 1000 and 1050. However, the problem is the tree-ring dates for the second set of Tusayan White wares were obtained entirely from the Flagstaff area, which is outside the area of its manufacture. This is compounded by the assumption that Flagstaff and Walnut Black-on-white were made in the Flagstaff area only after the eruption of Sunset Crater (Breternitz 1966; Colton 1955).

Overall, the northern white ware assemblage was too small and ambiguous to provide a quantitative resolution but several observations can be made. First, the motifs, design, and stylistic attributes found on tree-ring dated Cibola White wares Gallup and Escavada Black-on-white recovered from sites within the area of their manufacture (Hayes-Gilpin and Hartsveldt 1998), compared to Sosi, Flagstaff, and Dogoszhi Black-on-white, suggest the transition of these Tusayan types initially occurred between AD 1000 and 1050. This apparent early eleventh-century regional transition of Whiteware types would roughly correspond to the date range provided for Middle Sacaton 1 Red-on-buff (Wallace 2004). In turn, the date ranges provided the various northern white wares recovered from LVA sites appear to support Wallace's (2004) chronology for Middle Sacaton 1 Red-on-buff in the early eleventh-century. Third, as the LVA buff ware Trend III was directly associated with Middle Sacaton 1 Red-on-buff, the LVV abandonment was associated with a significant decrease in buff ware procurement. Moreover, as Middle Sacaton 2 and Late Sacaton Red-on-buff were absent, the process of abandonment seems to correspond to the date range of Middle Sacaton 1 Red-on-buff. Lacking diagnostic types**,** the sherd count data amassed thus far seems to support this conclusion. However, additional data confirming the presence or absence of Middle Sacaton 1, Middle Sacaton 2, and Late Sacaton Red-on-buff is required to verify this observation and more precisely determine the full extent of the LVV abandonment.

Trends and the LVV Abandonment Process

While our methodologies differ from those of Wallace (2004), the use of some of the same ceramic data, and the revised Sacaton typology, with important differences, our findings were similar to those of Abbott (2007b) in the New River area. Our analysis indicated that PBA Trend III and LVA Trend II represent the peak of Hohokam buff ware production/procurement, with Santa Cruz and Early Sacaton Red-on-buff the principal buff ware types. Although buff ware percentages were slightly lower, this roughly corresponds to Abbott (2007b) New River small site occupation. Chronologically, this was dated before AD 1000, possibly extending from the early to late tenth-century. The sherd count sequence also indicates the abandonment of the LVV occurred during the subsequent PBA Trend IV and LVA Trend III. This corresponds to an episode of significantly declining buff ware production/procurement as Santa Cruz and Early Sacaton Red-on-buff were replaced by Middle Sacaton 1 Red-on-buff. For Abbott's (2007b) New River study this corresponds to the abandonment of the small settlements and aggregation at the Palo Verde Ruin.

However, at the Palo Verde Ruin in the North Metro district, very little Middle Sacaton 1 was found and Middle Sacaton 2 Red-on-buff was far more common (Abbott 2007a), which appears to be due to the sampling strategy (Marshall 2009). This contrasts with sites in the LVV and Four Peaks districts where Middle Sacaton 1 was present but Middle Sacaton 2 and Late Sacaton

Red-on-buff were absent. Situated beyond the LVV area of abandonment it seems that the Palo Verde Ruin continued to be occupied after AD 1050. Moreover, the prevalence of Middle Sacaton 2 Red-on-buff suggests that the Palo Verde Ruin reached its greatest extent only after the LVV was abandoned. This also contrasts with the Veres Site, in the Desert Foothills district located on the northwest edge of the LVV area of abandonment. Here Early and Late Sacaton Red-on-buff were present but both Middle Sacaton 1 and 2 were absent (Smith 2001). This is also different from the Scorpion Point Village where Middle Sacaton 1 and Late Sacaton were present but Middle Sacaton 2 Red-on-buff was absent. But again this site was located in the Horseshoe district outside of the LVV area of abandonment. With the abandonment of the Palo Verde Ruin around AD 1070 (Abbott 2007a) much of the lower New River and Cave Creek drainages were depopulated (Hackbarth et al. 2007; Marshall 2009) except for several small settlements. Largely because Middle Sacaton 2 Red-on-buff was absent the LVA procurement Trend III was extended to cover the same period as PBA production Trend V.

The transition from LVA procurement Trend II and III also suggest that the LVV abandonment happened as a two-phase process, rather than a single sudden event. Based on the prevalence of Santa Cruz and Early Sacaton Red-on-buff we assumed that during the first phase settlements along the Salt River and in upland areas were initially abandoned. This was followed by population aggregating at large settlements along the Verde River before the final abandonment of the LVV. However, upon a more detailed review of principal buff ware types, examples of Middle Sacaton 1 Red-on-buff were identified at one Salt River and several upland sites confirming our initial assessment was in error. Therefore, it appears that the LVV population aggregated in both the riverine and upland settings during the first phase before the abandonment of the entire LVV and surrounding areas in the second phase. This was confirmed by a reassessment of the seriated sherd count data. Nevertheless, the transition from PBA Trend III-IV and LVA Trend II-III corresponds with the initial abandonment of sites in the LVV, Four Peaks, and Horseshoe districts. Abbott et al. (2007b) dated the New River small site abandonment around AD 1000. This is relevant to our study because the circumstance and sequence surrounding the initial abandonment followed by population aggregation in the New River area appears to be part of the same process associated with the first phase of the LVV abandonment.

Based on the LVA buff ware Trend III sherd count data, it seems that with local abandonments, population aggregated, forming new settlements or expanding existing villages. The best example of this was Azatlan which tripled in size in the early eleventh-century with four ball courts, four plazas, 98 trashmounds, and numerous extramural areas surrounded by several dozen small outlying settlements. A series of small Casa Grande style ball courts were also constructed at the settlements situated between the Verde Bridge and Horseshoe Reservoir. This second phase terminated around AD 1050 with the comprehensive abandonment of all of the villages along the Verde River and in the surrounding uplands south of the Horseshoe Reservoir. The best examples for dating the climax of this phase are AZ U:6:213(ASM) near the Verde and Salt River confluence where Middle Sacaton 1 Red-on-buff was found (see Figure 4-3C and 3D), and AZ U:6:228(ASM) a small outlier of the Azatlan Village complex (see Figure 4-1). At the latter site, two of three contemporary burned pithouses had intact floor assemblages (Birnie et al. 1995) that included Middle Sacaton 1 Red-on-buff jars (see Figures 4-2, 4-3A, and 3B).

Most of the remaining settlements in the Four Peaks district situated at the lower elevations along Sycamore Creek were also abandoned at this time. Of these, the best examples were AZ U:3:87(ASM) and AZ U:3:337(ASM) where Middle Sacaton 1 Red-on buff was present (see Figures 4-3E and 3F). As buff ware procurement continued to decline throughout the LVA, the abandonment process concluded with both Middle Sacaton 2 and Late Sacaton Red-on-buff being conspicuously absent throughout the LVV. Although diagnostic ceramics were not present**,** two sites in the Four Peaks district, situated on the eastern edge of the LVV abandonment area, may have been occupied as late as AD 1100. These were AZ U:3:83(ASM) and AZ U:3:341(ASM) where a single extended inhumation burial was found at each site. The sherd count data from the PBA subset also suggests a similar process of abandonment in the Lower Agua Fria and North Metro districts except for the Palo Verde Ruin. Here population appears to have significantly increased expanding the size of the village until AD 1070 when this settlement was also abandoned. The subsequent LVA Trend IV represents the continued decline of buff ware procurement with two of the best examples at AZ U:2:80(ASM) Locus A in the Horseshoe district and AZ U:1:159(ASM) in the Desert Foothills district. The diagnostic decorated types were Late Sacaton Red-on-buff and Black Mesa Black-on-white at the latter site with Late Sacaton and Casa Grande Red-on-buff (see Figure 4-3G and 3H) in association with Holbrook and Walnut Black-on-white at the former site. These ceramic assemblages indicate occupations after AD 1050 that extended into the twelfth-century.

DISCUSSION

How does our study advance an understanding of the pre-Classic LVV abandonment and similar events in the PBA? Rather than a sudden event, it appears that the LVV abandonment was a half-century-long process that involved demographic aggregation and reorganization. Applying Wallace's (2004) and Abbott et al.'s (2007b) collaborative revisions, sequence, and chronology it is apparent that the PBA Trends IV and V occurred between AD 1000 and 1070. This was contemporary with the LVA Trend III which more or less corresponds to the LVV abandonment, as outlined above. In the PBA, we find a similar and contemporary process at sites such as Los Solares/La Ciudad, La Lomita, La Lomita Pequena, Snaketown, Grewe, Los Hornos, Pueblo Grande, and even Casa Grande (Abbott et al. 2007b; Craig 2001; Craig and Woodson 2017; Doyel 2000; Henderson 1987, 2001; Mitchell 1988, 1990). However, unlike other large villages, Snaketown and Grewe were effectively abandoned around AD 1070 (Abbott et al. 2007b; Craig 2001). Therefore, abandonment of a major production site like Snaketown would explain the general decrease in buff ware use after AD 1070. Although buff ware production has been documented in the Queen Creek district (Lack et al. 2012) this source did not become important until after Snaketown was abandoned. Moreover, it is interesting that except for the production spike associated with PBA Trend VII, which dates 150 years after Snaketown's abandonment, the volume of buff ware production fell to very low levels.

The process of abandonment, aggregation, and reorganization began around the same time and are similar and it is tempting to seek commonality in cause and effect. However, there are important differences as the final phase of LVA and PBA abandonments occurred at least 20 years apart. The most striking example is the lower New River area in the North Metro district where Abbott et al.'s (2007b) evaluation of Doyel and Elson's (1985b) study found numerous small sites associated with Santa Cruz and Early Sacaton Red-on-buff were abandoned around AD 1000. More recently excavations at the Rock Springs (AZ I:8:169[ASM]) and Terrace Garden (AZ I:8:19[ASM]) sites seem to confirm this assessment (Marshall 2009). Abbott et al. (2007b) also proposed the local population aggregated at the Palo Verde Ruin around AD 1000. Based on the low frequency of Santa Cruz, Early Sacaton, and Middle Sacaton 1 Red-on-buff Marshall (2009) suggests that this aggregation of the local population expanded a preexisting settlement, forming the central portion of the Palo Verde Ruin. The relative abundance of Middle Sacaton 2 Red-on-buff and Black Mesa Black-on-white (Abbott 2002) indicate a large influx of people around AD 1050. This greatly expanded the size of the Palo Verde Ruin until its abandonment around AD 1070.

What factors caused or contributed to the collapse and abandonment of the LVV settlement system and how does that relate to a similar process in the PBA? Given the general environmental setting of the Upper Sonoran Desert, long term residency was dependent on springs and a few relatively small perennial rivers and streams. Therefore, the availability of surface water and climatic fluctuations are necessary for nomadic survival, and even more critical for sustaining sedentary subsistence economies. Within this context, the Lower Salt and Verde Rivers represent a reliable and indispensable resource with seasonal streamflows common in the Agua Fria River and the numerous tributaries that drain the surrounding uplands. However, the amount of surface water in these secondary drainages is variable from year to year, dependant on the prevailing climate.

A synthesis of numerous tree ring chronologies that used thousands of tree ring samples (Benson et al. 2007; Herweijer et al. 2007; Ni et al. 2002; Woodhouse et al. 2010) was the basis for Benson and Berry's (2009) paleoclimatic sequence defining the Southwestern megadrought cycle. When compared to our proposed chronology for the LVV abandonment several correlations are apparent. First, the peak Hohokam buff ware production fits neatly between Benson and Berry's (2009) First (AD 860 to 880) and Second (AD 990 to 1050) Southwestern megadroughts (see Figure 3). The Second megadrought roughly corresponds to the chronology provided for Middle Sacaton 1 Red-on-buff (Wallace 2004), the significant decrease in buff ware production, and the LVV abandonment. In summary, this climactic event seems to have fluctuated from severe, to slightly less severe (see Benson and Berry 2009.) as it was preceded by a short yet high-intensity drought starting around AD 980. Third, the onset of the less intense second phase of this megadrought began around AD 990 and persisted until AD 1020 when normal conditions returned. However, within a few years, the high-intensity drought returned that lasted several decades, ending around AD 1050 (Figure 5, see also Figure 3).

Applying the paleoclimatic megadrought sequence suggests that the first phase of the LVV abandonment associated with small sites began in the closing years of the tenth-century. This implies the subsequent population aggregation likely occurred in the early eleventh-century which may correspond to a brief decline in the megadrought's severity (see Figures 3 and 5). We may also conclude that the second phase culminating in the depopulation of the LVV district transpired before AD 1050. Based on the absence of Middle Sacaton 2 and Late Sacaton Red-on-buff, together with Benson and

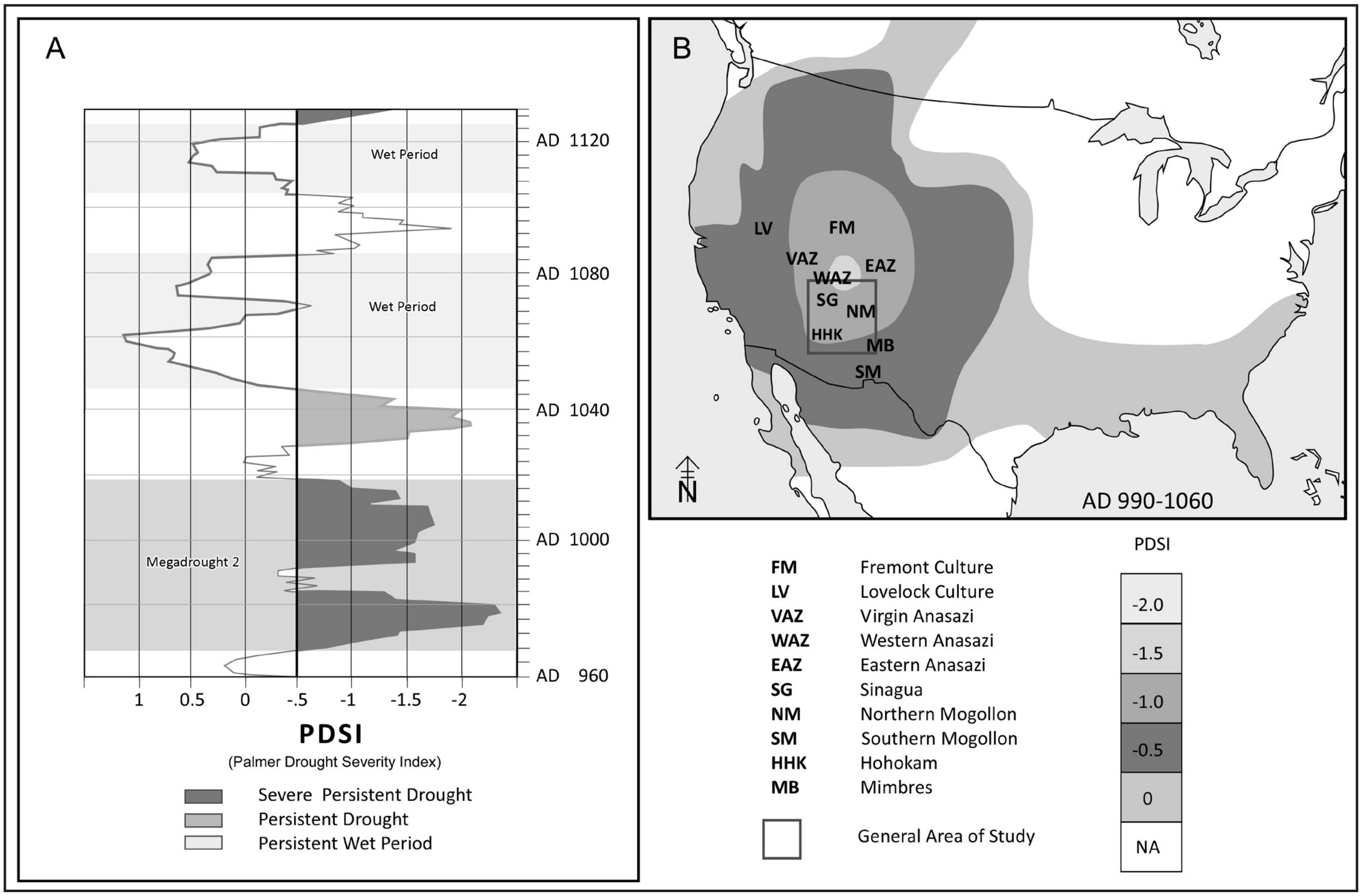


Figure 5 . A) Two hundred year sequence of megadrought and wet periods according to the PDSI, adapted from Benson and Berry (2009b), B) geographic extent of the second Southwestern megadrought adapted from Benson and Berry (2009b).

Berry's (2009) paleoclimatic reconstruction, there is no evidence for an occupation of the LVV district after AD 1050. However, in the PBA North Metro district, near the western edge of the LVV area of abandonment, the Palo Verde Ruin experienced a significant influx of population expanding it to its maximum extend (Abbott 2002; Hackbarth et al. 2007; Marshall 2009). According to Benson and Berry's (2009) megadrought model, this roughly corresponds to the period between AD 1050 and 1080 when increased rainfall and local streamflow lessened the effects of environmental stress accumulated over 70 years of nearly continuous drought. Although the climate appears to have shifted to an unusually wet regime between AD 1050 and 1125 this was interrupted by a brief yet severe drought after AD 1080. Interestingly, this short drought is contemporary with the date Abbott et al. (2002) provided for the abandonment of the Palo Verde Ruin.

Returning to the PBA, studies by Doyel (1993), Wallace (2004) and Abbott et al. (2007b) indicate the waning years of the Hohokam ballcourt system and Snaketown's final florescence followed by its decline and abandonment occurred between AD 1050 and 1070. This also roughly corresponds to the early portion of Benson and Berry's (2009) first wet period between dated AD 1045 and 1080. Although areas with the highest Palmer Drought Severity Index (PDSI) levels were situated in north-central Arizona, the effects of prolonged episodes of drought and increased precipitation were experienced in south-central Arizona, as well (Ely 1997). Figure 5 provides a map showing the extent and a graph showing the severity of the second Southwestern Megadrought, as well as intensity of the First Southwestern Wet period adapted from Benson and Berry (2009). Radiocarbon dating of charcoal recovered from channel alluvium indicate that sometime between AD 1020 and 1160 the Middle Gila River experienced downcutting, channel braiding, and subsequently significant loss of floodplain (Waters and Ravesloot 2001). Undoubtedly, these processes were due to flooding, but it is unclear if they were the result of extremely low streamflows experienced during Benson and Berry's (2009) First and Second Megagroughts. Another possibility is fluctuating high streamflows associated with

Wet Period 1 as part of a widespread climatic regime that affected the southern Southwest (Ely 1997). Moreover, as Woodson (2010) found a contemporary extension of the Snaketown canal system and its integration with other systems as far upstream as Granite Knob it is also unclear whether flooding and downcutting or erratic and periodic low streamflow was the critical factor.

We may also ask what motivated a large, sedentary population to abandon one of the most agriculturally productive and well-watered areas in the Southwest. Our proposed chronology indicates the LVV abandonment occurred during Benson and Berry's (2009) Second Southwestern Megadrought. Increased competition for critical resources aggravated by environmental stress leading to increased cooperation and Internecine warfare brings to mind any number of social anthropology models (Axelrod and Hamilton 1981; Fuentes 2004; Molina et al. 2017). In this context, we may speculate that water and irrigatable farmland represent critical resources. However, conclusive evidence of warfare is somewhat meager consisting mainly of numerous burned pithouses. Of these, the vast majority were systematically abandoned prior to burning; particularly those found at LVA sites abandoned in the late-tenth-century. Still, evidence of conflict is evident; for example AZ U:6:88(ASM), part of a small residential settlement situated in an upland setting in the Four Peaks district. Here a partial floor assemblage and the disarticulated remains of an adult on the floor of a burned pithouse (Greene 1990) suggest a violent end. The partial remains of two additional unburied adults were also found covered by alluvium in a small nearby wash. Many of the eleventh-century pithouses excavated at sites along the Verde River were burned, as well. Of these, the best example is the previously mentioned burned pithouses with complete floor assemblages at AZ U:6:228(ASM) on the outskirts of the Azatlan community complex (Birne et al. 1995).

A more persuasive argument for warfare can be found in the numerous small late pre-Classic residential sites scattered throughout the LVA uplands (Figure 6). Based primarily on extensive surveys, these settlements descend from the Perry Mesa district via the Agua Fria River and near New River turn eastward in a wide arc crossing the Verde River below Horseshoe Reservoir (Crary 1991). Turning southeast the distribution of these sites continues on the western slopes and summit of the Matzazal range, terminating in the Four Peaks area. A similar group of small settlements extends north from the Horseshoe area along the Verde River with yet another group clustered as far north as the East Verde River in the Wilderness district. Based on limited investigations (Bruder 1982; Fiero et al. 1980; Klucas 1999; Marshall 2001; Russell 2017; Sporel 1979; Sporel and Gummerman 1984; Vanderpot et al. 1999) these sites date after the abandonment of the LVV. Typically centered on small springs, they form small communities each associated with a large encloser situated on extremely steep and defensible terrain. Referred to as Refugium (Crary 1991; Doyel and Crary 1995a) and Redoubts, these massive dry-laid masonry structures are imposing and reflect a certain degree of community integration and organization. They also represent huge investments in labor comparable to that associated with the construction of ball courts or platform mounds. Towering above the surrounding territory, there is little doubt they were built to defend against perceived threats (see Crary 1991; Crary and Motsinger 1996; Doyel and Crary 1995a; Klucas 1999; Russell 2017; Sporel 1979; Sporel and Gummerman 1984) as the majority overlook routes emanating from the PBA.

Around the time Refugia communities appeared in the LVA, immediately southwest of the LVV, the Scottsdale canal system was significantly enlarged. Here, numerous small settlements and several large villages were established on the upper terraces north of the Salt River (Doyel and Crary 1995b). Some of these new sites were the result of consolidating small local settlements, but this rapid expansion was so extensive it cannot be explained entirely by internal aggregation. Therefore, we suggest that as the LVV was abandoned some of the population scattered throughout the LVA uplands while others resettled in the area covered by the Scottsdale Canal System (see Figure 6-B).

Another argument for warfare as causality is that despite its rich resource base, and a brief attempt at resettlement in the late thirteenth and early fourteenth centuries (Canouts 1975), the LVV remained unoccupied until Fort McDowell was founded in the mid-nineteenth century. This, together with changing settlement patterns that followed the diaspora, suggests that the LVV remained unoccupied due to a fundamental change in how the PBA and LVA populations interacted. Speculatively, this change likely involved some form of warfare where the force needed to expel and inhibit a reoccupation could be mobilized, the parties involved lacked the resources required to stage a sustained reoccupation. Because the LVV remained unoccupied for hundreds of years, the cause of initial abandonment may not be directly related to the reason it remained depopulated. Furthermore, we may view the abandonment of the LVV as part of a much larger phenomenon that effectively created a huge depopulated buffer zone that surrounded the PBA (Doyel and Crary 1995a; Fish and Fish 1989).

Finally, we may also consider how the periodic interruption of the exchange of goods and services associated with the Hohokam ballcourt system may

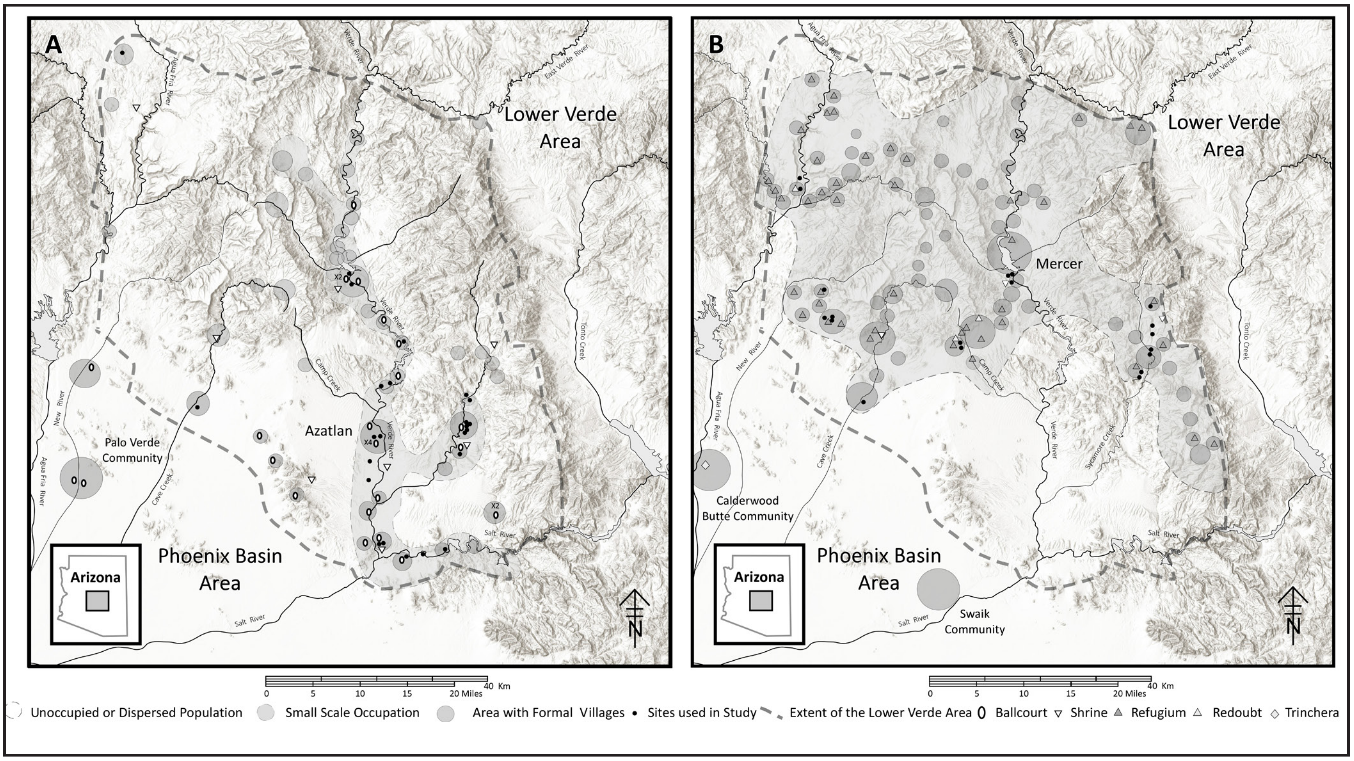


Figure 6. A) LVA settlement system between AD 950 and 1070, and B) LVA settlement system between AD 1070 and 1150.

have contributed to the LVV abandonment. Abbott et al. (2007b) reviewed theories concerning how ball courts functioned (Doyel 1991; Haury 1976; Wilcox 1991; Wilcox and Sternberg 1983) and proposed the development of a nascent market system where individuals used the exchange of pottery, prestige items, and common domestic goods within a ritualistic context to form obligations and build constituencies. Using the petrographic analysis of buff ware found at sites in the West and East Metro districts, Abbott et al. (2007b) supported the nascent market theory by demonstrating the vast majority of these vessels were made in the GRIC district near Snaketown. Similar geographic distinctions were found between tempering materials, plain ware manufacture, and ceramic exchange at sites found throughout the PBA while many of these interactions ended in the late eleventh century when the use of ball courts appears to have ceased. However, the Hohokam ballcourt may have also served to channel competition and foster regional cooperation in the LVA using kinship ties and reciprocity to reinforce group identity.

Abbott et al. (2007b) posit that the Hohokam ballcourt system centered on Snaketown reached its zenith between AD 1020 and 1080, yet also found that buff ware production decreased at the same time (Abbott et al. 2007a). Indeed, the results of our study agree with this assessment, as buff ware production appears to have peaked in the mid to late-tenth-century. While far less buff ware is found outside of the GRIC district after AD 1000, we would add that within the GRIC buff ware production rebounded significantly by the mid-eleventh century. Nevertheless, there seems to have been a brief period of perhaps several decades, between the late tenth and early eleventh centuries, when buff ware production dropped to a very low level. In the LVA the pronounced reduction in buff ware procurement, as well as shell and stone jewelry, ornate projectile points, and palettes undoubtedly represents the decline or cessation of the ballcourt system. With the means designed to mitigate competition removed, we can only speculate that the socioeconomic response led to increased violence and some form of organized conflict. If early Snaketown type ball courts fell into disuse in the late tenth-century, were the Casa Grande type ball courts build in the early eleventh-centuryan attempt to revive the ballcourt system? With the ballcourt system at its greatest extent, and buff ware procurement outside of the GRIC district relatively low throughout the eleventh-century, one might also ask what replaced decorated pottery as the item used to assess the value of other commodities.

Final Thoughts

With population dispersed throughout the LVA uplands or resettled in the PBA, what are the wider implications of the LVV abandonment? With a cause rooted in megadrought (Benson et al. 2007; Benson and Berry 2009), it seems likely that PBA communities became involved in conflicts initially centered in the LVA that eventually led to abandonment and prevented resettlement of the LVV. By extension, this abandonment also represents the genesis of a discrete tradition centered on the mountainous uplands of the LVA. These events transpired within a greater context as a phenomenal wave of rapid change swept across the entire Southwest. This was contemporary with the emergence of the Classic Mimbres (Anyon et al. 2017; LeBlanc and Whalen 1980; Lekson 1990, 2006), the Bonito phase of Chaco Canyon (Lekson 1984; Windes and Ford 1996), the northern Mogollon Reserve phase (Haury 1985; Martin and Rinaldo 1950), Winona phase Sinagua (O'Hara 1998), and Tusayan-Kayenta Anasazi Black Mesa phase (Powell 2002). Finally, although far beyond the scope and intent of our study, with the decline in buff ware production in the early eleventh-century, there was a distinct shift in Hohokam decorative style to tightly enclosed geometric motifs that closely resemble textile designs. These changes seem to crosscut cultural affiliation as they characterize the general layout of the geometric Classic Mimbres, as well as Reserve, Chaco, and Dogozhi Black-on-white designs, which may suggest the growing importance of cotton after AD 1000.

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