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Occupation of the Hinterlands

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guest editors

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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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THEMED ISSUE:

OCCUPATION OF THE HINTERLANDS

PREFACE

Deil Lundin and J. Simon Bruder, Guest Editors

Back in October of 2017, the Arizona Archaeological Council held its annual fall conference. Papers assembled for this volume were either developed from presentations generated by the event, or selected afterward based on its theme: Occupation of the Hinterlands. The topic was inspired by a career spent investigating sites on or beyond the outskirts of prehistoric settlement centers like the Phoenix or Tucson basins. The location, not entirely intentional but rather fittingly, was in Star Valley, on the edge of town, just below the Mogollon Rim. Maybe in part due to a sense of gratitude, and also stemming from personal interest, it seemed appropriate to highlight others' research in similar areas.

In southwestern archaeology, the term *hinterland*, much like periphery, is used to describe spaces surrounding or between population centers, aka. heartlands or core areas; often as a means of understanding how groups interacted within or among regional systems. Rather than a broader conceptual approach, this collection of articles focuses on use or occupation of areas characterized as hinterlands primarily at the community level by examining thematic contexts such as migration and cultural identity, settlement patterns, and material culture.

The five papers included here cover a range of topics, from the detailed consideration of a specific artifact type (Martynec and Martynec) to an exploration of the wide ranging connections of distinct cultural traditions (Shackley). The papers address the archaeology of east central Arizona (Arnett), south central Arizona (Medchill et al. and Shackley), southwestern Arizona (Langan) and western Arizona and southeastern California (Shackley).

The *Journal's* mission is to serve as a platform for the presentation of emerging ideas, new methods, and current research in Arizona archaeology. Each of the papers included here exemplify one or more of these goals. Abraham Arnett investigates changes in Ancestral Puebloan settlement and land use in the Hay Hollow Valley using geographic information system (GIS) based analyses. An updated typology for pithouses in the eastern Papaguería is presented by John Langan. Richard and Sandra Martynec describe the morphological characteristics and distribution of stone spheres throughout the western Papaguería and provide possible functional interpretations. Brian Medchill, Chris Loendorf, and Kyle Woodson report on circular pedestals identified as the bases of granaries in a platform mound site on the middle Gila River; while common in peripheral areas, such features are rare in the Hohokam heartland, and thus, may indicate close ties to the periphery or be evidence of immigration. Finally, Steve Shackley explores connections between the Hohokam and Patayan during the pre-Classic period.

We thank each of the authors who contributed to this issue. Thanks also to Jenny Adams, Mark Elson, Randy McGuire, Matt Peeples, Rein Vanderpot, and Scott Wood along with five anonymous peer reviewers. Cathi Gerhard provided copy editing services. The *Journal's* former editor Glen Rice initiated the process of soliciting papers and identifying reviewers for this issue, and the current editor, Doug Mitchell, took up the reins at the beginning of the year. Our thanks to both of them, and to managing editor Erik Steinbach for pulling it all together.

SAUL L. HEDQUIST
1980–2018

Saul Luther Hedquist, a Southwest Archaeologist, passed away peacefully at his home in Tempe, Arizona, on Sunday, November 4, 2018. He was only 38. Saul was a rising leader in the field of archaeology and garnered great respect for his superb scholarship, and for his enthusiasm for working collaboratively and across disciplines. His success stemmed in part from his genuine love for interacting with people. Saul had a natural ability to be fully present during even the most casual of conversations with both colleagues and friends.

Saul was born September 16, 1980, to Nona Meyer and Paul Hedquist and grew up in Des Moines, Iowa. He graduated from Hoover High School in 1999 and from the University of Northern Iowa in 2003. Saul was always enamored of history, culture, and the outdoors. In college he channeled these interests into an anthropology major. His dedication to anthropology brought him to Flagstaff in 2004, where he received a master's degree in anthropology from Northern Arizona University (NAU) in 2007. His thesis focused on the relationship between exotic material culture and social complexity within the Sinagua who lived in the region in the eighth through fourteenth centuries. His MA research led to his long-term interest in turquoise.

Soon after arriving at NAU, Saul was introduced to the rich, enduring Indigenous communities that literally surround Flagstaff, sparking his future desire to include their perspectives in his research. Immediately following his MA, Saul launched his career in the CRM community that continued to the end of his life. Throughout his CRM career, Saul directed crews who respected his attention to detail and respectful treatment of people working with him. He encouraged multiple perspectives on how to interpret the archaeological record.

While working part-time in CRM, Saul began his doctoral studies in anthropology at the University of Arizona in Tucson, where his research focused on the cultural significance, exchange, and multiple uses of turquoise in ancient and contemporary Puebloan communities in the American Southwest, particularly the Hopi and Zuni. In May 2017, he received his PhD in anthropology. His dissertation was unique and innovative in looking at turquoise circulation through multiple lenses: by where it was deposited within large Pueblo communities in the fourteenth century; by sourcing it through lead/strontium isotopic analysis; and by interviewing dozens of Hopi and Zuni descendants of these early Pueblo communities to include their perspectives on the value and meaning of turquoise. As a result of this research, Saul learned that turquoise referred not only to the mineral form but also to a much broader cultural category that included objects painted blue or green with copper oxides. Saul presented his findings to cultural advisors at Hopi and Zuni and was working on converting his dissertation into a book, strongly encouraged by the University of Arizona Press.

During his short career, Saul was tremendously productive and, above all else, collaborative in his research and publications. With rare exceptions, he co-authored chapters, articles, and technical reports with colleagues, including Indigenous scholars. This collaborative spirit was a natural outgrowth of who Saul was as a human being, always showing respect toward alternative viewpoints and including them in his research.

It is not surprising that most of all, Saul loved being with his family and friends. He was an avid outdoorsman and spent many happy days hiking, camping, fishing, running, listening to music, and playing disc golf with friends and family. Saul wanted nothing more than to make other people happy and to do good in the world. On both fronts, he was tremendously successful, and he is missed by all who were fortunate to love, know, or work with him.

Saul is survived by his wife, Leigh Anne Ellison; daughters Chelsea and Leila Hedquist; his mother, Nona Meyer; father and step-mother, Paul and Meg Altmix-Hedquist; brothers Seth Hedquist and Zach and Jake Simmons; and his mother- and father-in-law, Sandy and Jeff Ellison.

Saul Hedquist's list of publications can be found at the SAA website.

—Leigh Anne Ellison, E. Charles Adams, T.J. Ferguson, and David J. Killick

THE PATAYAN AND HOHOKAM: A VIEW FROM ALTA AND BAJA CALIFORNIA

M. Steven Shackley

ABSTRACT

The relationship between the Patayan, the ancestors of today's Yuman groups in western Arizona, southern Alta California, and northern Baja California, and the Hohokam of central Arizona has been of some interest in the archaeological community of the Southwest, particularly in Arizona. The understanding of that relationship in the Southwestern archaeological community is somewhat disadvantaged by a lack of knowledge of the culture history and archaeological and historic inquiry into the Patayan and their descendant Yuman groups along and to the west of the Colorado River. Outlining the investigation of this Patayan-Hohokam relationship in Arizona, coupled with evidence from the Californias, clarifies this relationship and illuminates the vestige of the Hohokam world among historic Yuman groups, particularly the Kumeyaay (historically called Diegueño from the Spanish moniker or Tipai/Ipai) of Imperial and San Diego Counties of southern California, and northern Baja California. This movement to the west was driven by migration first to Lake Cahuilla in what is now the Salton Basin of southeastern California, and ultimately, to the San Diego and Tijuana coast. That vestigial Hohokam social and material order signals the close affinal or probable consanguineal relationship between the Patayan and Hohokam in central Arizona, particularly during the Hohokam Preclassic.

> There are also suggestions of connections between the Huhugkam and the people of the Colorado River Valley (Russell 1908:226-230; see also Shaul and Hill 1998), and what is now California (Bahr et al.1994:108-109). Recent linguistic research suggests the Hohokam archaeological culture included multiple ethnic groups (Shaul and Hill 1998), and it is likely that many different ethnolinguistic groups are encompassed by the term "Huhugkam" (From Hill et al. 2015:641).

> Local Patayan residents [at Las Colinas] ... were clearly accepted and integrated members of the larger community... [the Patayan households] were no different from other residence groups (Abbott et al. 2012:991).

> Aspects of the Patayan ceramic tradition eventually became part of the broader protohistoric ceramic tradition in the southern U.S. Southwest, including Patayan vessel forms and manufacturing techniques (Beck and Ferguson 2016:263).

> ... the Hohokam cremation rite, like the Yuman, was the central religious ritual of the society Evidence at La Ciudad suggests that the cremation ceremony was a public rite requiring the interaction of different courtyard groups ... the ritual with the courtyard group clusters defines a group identity, while the execution of the rite links different clusters (McGuire 1992:153).

Arizona prehistorians have long witnessed a relationship between the Patayan/Cohonina and Hohokam demonstrated archaeologically and linguistically throughout the region (Abbott 2000; Abbott et al. 2007, 2012; Beck 2006, 2008; Beck and Ferguson 2016; Beck and Neff 2007; Beck 2009; Beckwith 1988; Doyel 2008; Gregory and Abbott 1988; McGuire 1982, 1992; Schroeder 1957, 1975; Shackley 1998, 2004, 2019; Walsh 2007; Waters 1982; Wright and Hopkins 2016). That relationship is more multifaceted than generally realized in the Arizona archaeological literature and extends west to the southern California and northern Baja California coasts. Decades of archaeological research on both sides of the Colorado River has generally been conducted in a vacuum with little communication between the Cali-

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fornia and Arizona scholars. Late Prehistoric migration toward what is now California appears to have been facilitated by frequent fillings of Lake Cahuilla in what is now the Imperial Valley by natural flooding due to rerouting of the Colorado River into the Salton Basin beginning around AD 700 continuing through five or six filling events until the 18th century (Laylander 1997; Philobosian et al. 2011; Waters 1980, 1983; Wilke 1978; Figure 1 here). This phenomenon pulled Patayan and possibly some related Hohokam to the west in corresponding intervals eventually populating or re-populating the entire coast by sometime after AD 1100-1200 (Quinn and Burton 2016; Schaefer 1994; Shackley 1998, 2004, 2019). Much of the material culture of the prehistoric Kumeyaay in that region bears a striking resemblance to Preclassic (Sedentary) Hohokam that continued until the Spanish and Anglo intrusion and the destruction of the Prehispanic lifeway (Beck and Ferguson 2016; Cuero 1970; Shackley 2004;). Several well documented Kumeyaay social traditions based on mortuary practice and architecture and associated mortuary objects including projectile point style also suggest a continuing vestigial Hohokam social ideology surviving among many Yuman groups, most especially the Kumeyaay, probably the descendants of the first groups moving west from what is now Arizona. Floodwater agriculture among the Colorado River Yumans and the Kumeyaay who lived along the New and Alamo Rivers in the Salton Basin, unlike any other groups in California or Baja California, further signals the Southwestern origin of Yuman (Patayan) society.

MIGRATION AND SOCIAL IDENTITY

At numerous times in the last 14,000 years people in the U.S. Southwest have moved residence sometimes to the next community and sometimes to a remote region (Bayham and Shackley 1986; Mills et al. 2013a, 2013b; Shackley 1981, 1984, 1990, 1996, 2005). Indeed, it seems that many Southwestern groups rarely remained in a defined territory for any length of time (Clark et al. 2014; Shackley 1996).

In the early Classic (ca. A.D. 1200-1325) highland Mogollon groups moved into the Salt "arm" of the Tonto Basin setting up residence, establishing social networks, and exchanging goods and ideas with local groups who were previously influenced by Phoenix Basin Hohokam (Clark 2001; Rice 1998; Shackley 2005). The effects of migration can include displacement of one group by another, but more often results in co-residence of different migrant groups and local groups "within communities, settlements, and even households" (Clark 2001:4; see also Adams 1996; Haury 1958; Lindsay 1987; Mills 1998; Mills et al. 2013a, 2013b; Reid 1997). This is generally difficult to see in "intellectual" plan view standing on the platform of the present looking back to an earlier point in time. This is the challenge of the archaeological vision, and one that requires care in interpretation.

Viewing evidence and prevailing paradigms of the early twentieth century, vast amounts of new archaeological evidence and advances in method and theory since then argue for a multi-ethnic and multi-linguistic Hohokam. These diverse Hohokam left probable descendent communities among a number of modern Native American societies, particularly those now residing in central and western Arizona (Abbott et al. 2012; Beck 2008; Beck and Neff 2007; Doyel 2008; Gregory and Abbott 1988; Loendorf and Lewis 2017; McGuire 1982, 1992; Shackley 1984, 1998, 2004, 2005; Waters 1982; Wright and Hopkins 2016; Figures 1 and 2 here). Previous research illustrates linguistic similarities between Yuman (Patayan), previously called Hakataya by Schroeder (1957, 1975, 1979), and the probable language spoken by Hohokam groups, as well between O'Odham and curiously Zuni (Shaul and Andresen 1989; Shaul and Hill 1998). The plethora of historic linguistic and social relationships between the Hohokam and a variety of modern ethnic groups in the Southwest is of import, but not the focus here. The Patayan/Cohonina-Hohokam social interaction is the focus of this study.

PATAYAN/HOHOKAM MOVEMENT TO LAKE CAHUILLA AND THE WEST

During the Hohokam Colonial period after about AD 700 there are two sites on either side of the Colorado River (Bouse Wash and SDM-C1), with Patayan Buffware and Santa Cruz Red-on-buff in association, and one multi-component site (Indian Hill) that are relevant to the Preclassic Patayan/Hohokam relationship and the Patayan migration to the west.

Bouse Wash

At the Bouse Wash site, a stratified walk in well, in western Arizona (Figure 1) Harner recovered Patayan I ceramic types (Black Mesa Buff, Colorado Red) in the "Bouse Phase I" level below a unit containing Santa Cruz Red-on-buff indicating that the Lower Colorado Buffware series was at least as old as AD 700 (Harner 1958). Patayan Red-on-buffs apparently began shortly after this time since the Bouse Phase I pottery was all undecorated. Bouse Phase II included Gila Red and Verde Black-on-gray sherds dating between AD 1000-1300 (see Waters 1982). The upper levels at Bouse Wash, what Harner called the Moon Mountain Phase (AD 1300-1700), contained Patayan III ceramics including Lower Colorado Buffware and Lower Colorado Red-on-buff.

San Diego Museum of Man-C1

At SDM-C1 in Imperial Valley just to the west of the Colorado River (see Figure 1), two undisturbed pit shrines contained over 70 Patayan I vessels, mostly Black Mesa Buff and a few Colorado Beige and Black Mesa Red-on-buff in association with Santa Cruz Red-on-buff, indicating that these Patayan ceramics are both contemporaneous with Colonial Hohokam and must predate AD 900 (Rogers 1925, 1945; Waters 1982).

Indian Hill (CA-SDI-2537)

There is another important Imperial Valley site, in this case one that supports the late entry of the Patayan into the coastal region of southern California - Indian Hill (CA-SDI-2537; McDonald 1992; Wallace et al. 1962; Wilke et al. 1986; see also Shackley 2019). This rockshelter is located in the western Colorado Desert on the extreme eastern edge of the Peninsular Ranges near the San Diego and Imperial County lines (see Figure 1). The site contents and stratigraphy establish a chronology for the region that is reflected in sites from the Colorado Desert to the coast. There were two oc-

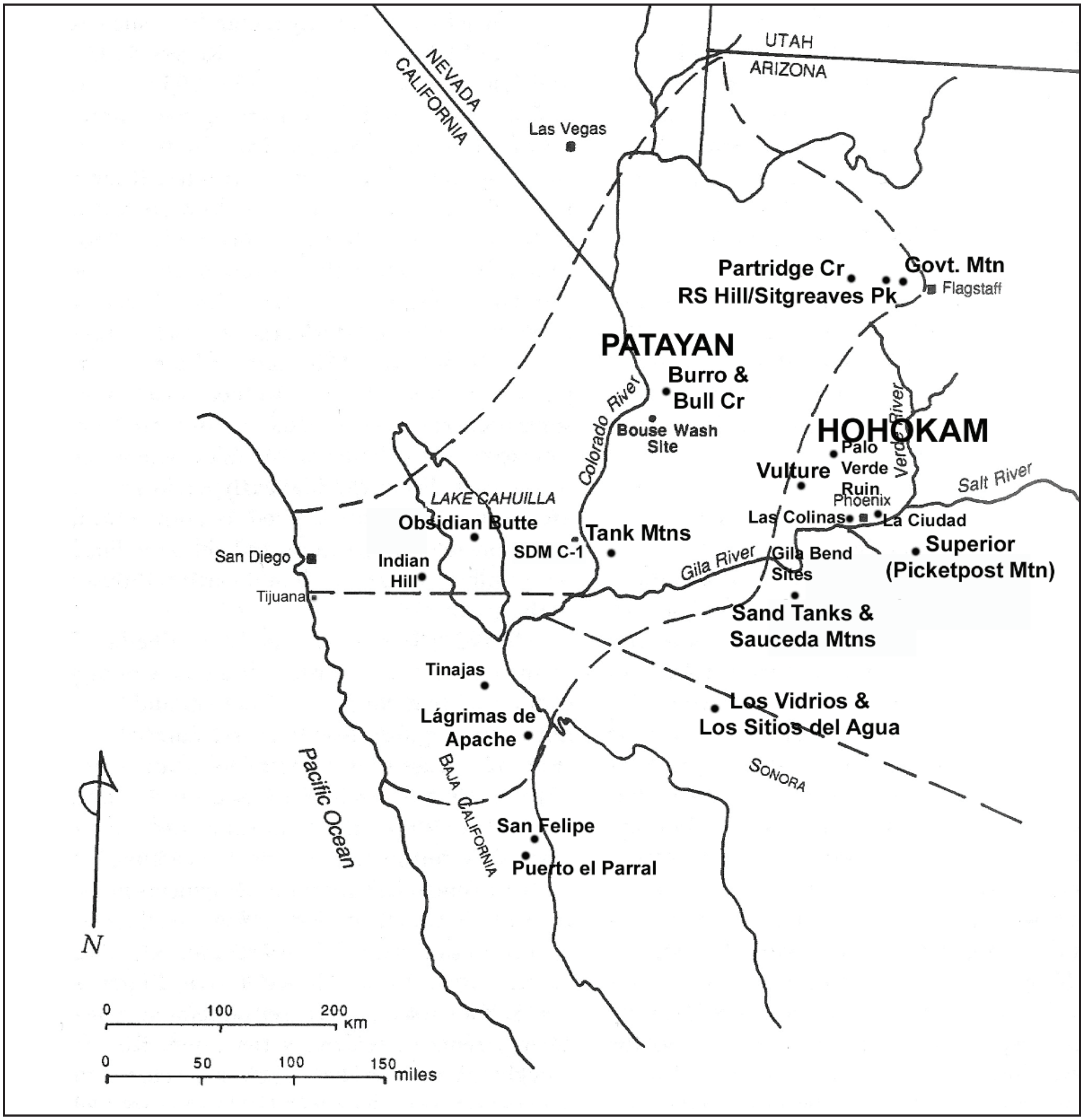

Figure 1. Hohokam and Patayan territorial distribution, prominent Hohokam and Patayan sites (filled circles in normal case), and approximate locations of relevant regional obsidian sources (filled circles in bold); (adapted from Gifford 1931; Gumerman and Haury 1979; Luomala 1978; Panich et al. 2017; Schroeder 1975, 1979; Shackley 1998, 2004, 2005; Waters 1982)

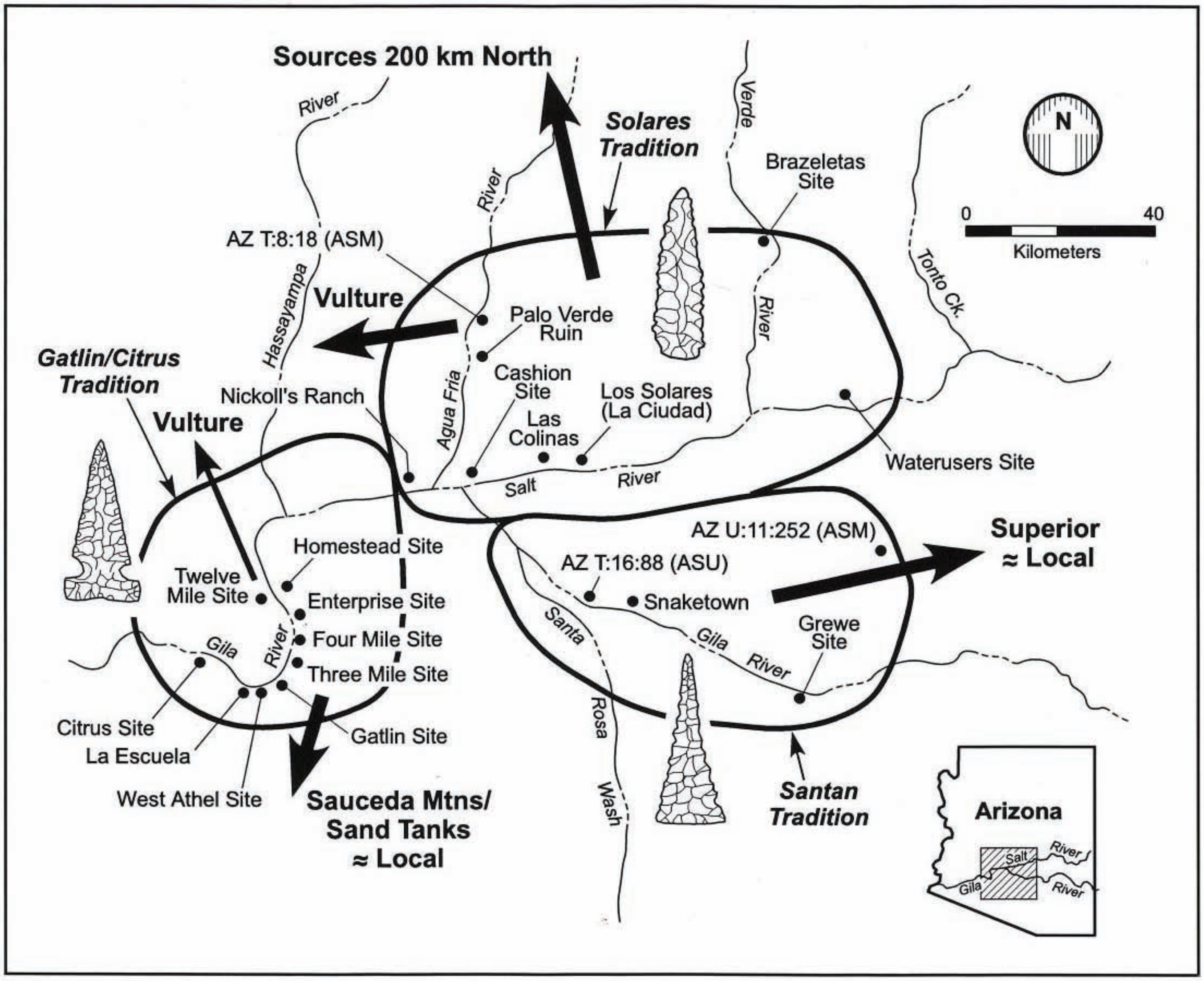

Figure 2. Hoffman's Sedentary Hohokam traditions and included sites, distinctive projectile point types, and directions to dominant sources of archaeological obsidian for each tradition in the Hohokam core area. Arrow thickness represents relative proportions of that source or sources in the various Hohokam traditions according to Shackley (2005).

cupations at the site: a Late Archaic occupation indicated by Elko Eared projectile points, with a number of radiocarbon dates between about 4000 bp (2873 BC) and 2600 bp (972 BC) and a Late Prehistoric occupation represented by Cottonwood Triangular, Desert Side-notched and Dos Cabezas Serrated projectile points and a radiocarbon chronology between 710 bp (AD 1257) and 260 bp (AD 1520; McDonald 1998:102). The occupation hiatus of over 700 years is reflected in the chronology throughout the region, including along the San Diego/Tijuana coast (i.e. Indian Hill, Santee Greens, CA-SDI-813, and CA-SDI-11,767), with occupation of the region in the late period by about AD 1100-1200 to the coast and with earlier occupations to the east in the Colorado Desert along the Lake Cahuilla shorelines (Berryman 1981; Cooley 1998; Gamble and King 2011:173; Philibosian et al. 2011; Quinn and Burton 2016; Schaefer 1988; Schaefer et al. 1987; Shackley 1984, 2004, 2019; Waters 1982; Weide 1976; Wilke 1978).

With the initial filling of Lake Cahuilla around A.D. 700, sites with Patayan I ceramics occur on the east shore of the lake about 60 km west of the Colorado River (Figure 1). No sites dating to Patayan I are present on the west shore of the lake or anywhere to the west during Patayan I (Schaefer 1988; Shackley 2019; Waters 1982; Wilke 1978). After AD 1000 with subsequent drying and re-filling of the lake during the Patayan II period, sites along the western shore begin to appear with Patayan II ceramics (i.e. Salton Buff, Tumco Buff, and red-on-buff versions of those wares; see Laylander 1997; Shackley 1984; Waters 1980, 1982). The filling of Lake Cahuilla actually contributed to Late Prehistoric migration into southwestern California by "pulling" populations of Patayan to the west from Arizona; and by AD 1300 the Patayan (Yuman) occupation of the area was firmly established, bringing with it a decidedly Southwestern (Hohokam) social organization and material culture from what is now Arizona. This Southwestern social and material milieu was successfully combined with what Kroeber would call a California lifeway based on balanophagy (acorn harvesting and production) and coastal resources (Kroeber 1925; Shackley 1981, 1984, 2004, 2019; see also Cooley 1998; Hicks 1963; Hoehenthal 2001; McGuire 1982, 1992; Schaefer 1994; Spier 1923; True 1970).

THE PATAYAN AND COHONINA MATERIAL CULTURE: LAS COLINAS AND PALO VERDE RUIN

During the 1980s, as the result of large cultural resource management studies in the Phoenix Basin associated with expanding freeway design and construction, a number of large Preclassic Hohokam sites were excavated. These include: Las Colinas, investigated by the Arizona State Museum, University of Arizona; La Ciudad (Los Solares), investigated by Arizona State University; and importantly here, Palo Verde Ruin, excavated due to US Army Corps of Engineers permitted housing development (Figures 1 and 2).

Las Colinas

One of the surprising finds at Las Colinas was the "Patayan Barrio" or "Yuman enclave" within what appeared to be a culturally homogeneous Preclassic Hohokam context (Abbott et al. 2012; Doyel 2008; Gregory and Abbott 1988). For a number of years, Patayan groups interacted in varying degrees with Hohokam irrigation communities on the western edge of the Hohokam territory in the Gila Bend area (Beck 2006, 2008, 2009; Beck and Ferguson 2016; Beck and Neff 2007; Doyel 2008; Figure 1 here). By about A.D. 1100 the distribution of Patayan material, particularly Lower Colorado Buff Ware, a Patayan III ware, and obsidian from western Arizona sources (Burro Creek, Bull Creek, Sand Tanks, Sauceda Mountains, and Tank Mountains) particularly Sauceda Mountains, began to appear eastward into the Hohokam core area (Shackley 2005; Shackley and Tucker 2001; see Figures 1 and 2 here). The Patayan concomitantly began to spread to the west as well, first around Lake Cahuilla and the lacustrine western shoreline by about AD 1000, and finally to the coast of San Diego and northern Baja California by about AD 1100 as discussed above (Bayman 1994; Beck and Ferguson 2016; Doyel 1996, 2008; Fertelmes et al. 2012; Laylander 1997; Loendorf 2010; Mitchell and Shackley 1995; Quinn and Burton 2016; Schaefer 1994; Shackley 1984, 1998, 2004, 2005, 2019; Waters 1982; Figure 1 here).

Beck and Neff (2007) and Shackley (1998, 2004) rejected the idea that this pattern resulted from exchange or "intrusive" objects moving into the Hohokam area. They instead argued that Patayan groups joined Hohokam communities (see also Abbott et al. 2012). Nowhere was this as obvious as at Las Colinas. In House Group XVII (1000-1150), Patayan sherds and reconstructable vessels were found in the house group and suggested some period of habitation beyond merely visiting (Abbott et al. 2012; Beck and Ferguson 2016; Beckwith 1988). Beckwith (1988) suggested that these vessels were produced in the Patayan territory. Conversely, Beck and Neff demonstrated, based on oxidation, chemical and petrographic analyses, that "Patayan potters could have made Lower Colorado Buff Ware from the local riverine clays ..." (Beck and Neff 2007:298). Subsequently, the geochemical and petrographic analysis of the Patayan sherds was interpreted by Abbott et al. (2012:991) that while the ceramics were not produced from local clays, the "evidence remains strong for a small Patayan enclave" at Las Colinas. As in many communities in the Hohokam sphere, perhaps the residents of House Group XVII did not make their own pottery, but obtained it through exchange with a kin group in the Patayan area, such as in the Gila Bend area (Bruder and Hill 2008). This is also the case in Sedentary Hohokam households outside the Middle Gila River production centers, where Sacaton Red on Buff was produced and subsequently distributed throughout the Hohokam core area (Abbott et al. 2007a, 2007b, 2012; Lack et al. 2012).

More recently Beck examined 355 sherds and ceramic pieces from Las Colinas with NAA, mainly to further clarify the distinction between Patayan Lower Colorado Buffware and Hohokam ceramics (Beck and Ferguson 2016). While the Patayan ceramics, based on the NAA analysis, cluster separately from the Hohokam ceramics in general with some minor overlap, the composition of the paste is not similar to the Patayan ceramics produced west of the Colorado River (see Hildebrand et al. 2002), but was likely produced elsewhere possibly "several-days walk [west] of Las Colinas using an undocumented source of phyllite temper (Beck and Ferguson 2016:262, 266-267, bracket mine). This western direction for Patayan ceramic production fits well with obsidian provenance and the presence of artifacts produced from obsidian sources on the probable territorial boundary of Patayan and Hohokam, also observed by Beck and Ferguson (2016; Figures 1 and 2 here).

At Las Colinas, the most common single source of obsidian used to produce chipped stone artifacts (nearly 30%) was from Sauceda Mountains, rarely seen in sites in the Phoenix Basin in Preclassic contexts (Loendorf 2012; Shackley 2005; Figure 3 here). In the Phoenix Basin, this source essentially replaced Superior (Picketpost Mountain) east of the Phoenix Basin by the Classic and Late Classic, possibly due to tensions between the Phoenix Basin and local groups to the east, and possibly territorial boundary shifts to the west as the Patayan moved west. It rarely occurs outside of Las Colinas during the Preclassic, however (Fertelmes et al. 2012; Loendorf 2012:107-114; Shackley 2005; Figure 2 here).

Abbott and others concluded that the "local Patayan residents . . . were clearly accepted and integrated members of the larger community" (2012:991). In addition to the Patayan vessels used in House Group XVII, were plainware and decorated Hohokam vessels indicating that the Patayan households "were no different from other residence groups" and were integrated members of the community (Abbott et al. 2012:991; c.f. Beck and Ferguson 2016). Both the Patayan and their Yuman descendants produced paddle-and-anvil pottery similar to Hohokam production technology; indeed the Patayan may have integrated this technology into Patayan society by the intimate relationship with the Hohokam (Beck and Ferguson 2016; Davis 1928; DuBois 1907; Rogers 1936; McGuire 1992; Shackley 1981, 1984; Van Camp 1979; Waters 1982).

Norton Allen, who excavated sites in the Gila Bend area, thought that "Yuman pottery" was common in Preclassic Hohokam sites in that area (Norton Allen, personal communication, 1966; see also Bruder and Hill 2008; Doyel 2008; Schroeder 1975). Presumably some Patayan ceramics could be in Allen's Gila Bend collections at Arizona State Museum, as well as the Patayan (Kumeyaay) pottery collected by Allen from San Diego and Imperial Counties, California curated at the San Diego Museum of Man (Ferg and Schwartzlose 2008). Margaret Beck's (2006, 2008) work in the western Paguería also revealed "Yuman Pottery" in Preclassic Hohokam sites. While the presence of non-Hohokam living and interacting with Hohokam at Las Colinas, in this case the Patayan ancestors of Yuman groups such as Cocopa, Kumeyaay, Mohave, and Quechan is apparent, where else could this be evident?

Palo Verde Ruin

One Preclassic Hohokam site in the western Phoenix Basin, Palo Verde Ruin, presents a similar pattern of social relationships. Archaeologists have suggested that this pattern might result from groups outside the Hohokam World residing in Hohokam communities (David Abbott, personal communication 2016; Marshall 2007; Shackley 2005).

Preclassic Hohokam projectile points have been the object of rather intensive typological as well as source provenance studies (Hoffman 1997; Loendorf 2012; Loendorf and Rice 2004; Marshall 2001, 2002, 2007; Shackley 2005; Figures 2 and 4 here)[1]. This research has focused on the variability in projectile point style that patterns with three sub-areas of the Hohokam core area, called "traditions" by Hoffman (Hoffman 1997; Shackley 2005; Figure 2 here). Both Hoffman (1997) and Shackley (2005) have argued that the obsidian provenance and projectile point styles of the Sedentary Hohokam suggest that Hohokam males were organized in what could be called sodalities differentiating themselves in these three areas of the Hohokam core (see Figure 2). Shackley (2005) suggests that the sodalities revolved around the organization of the ball games and canal irrigation, as part of a "small m" market economy as suggested by Abbott and others (see Abbott 2010; Abbott et al. 2007b, 2012; Watkins

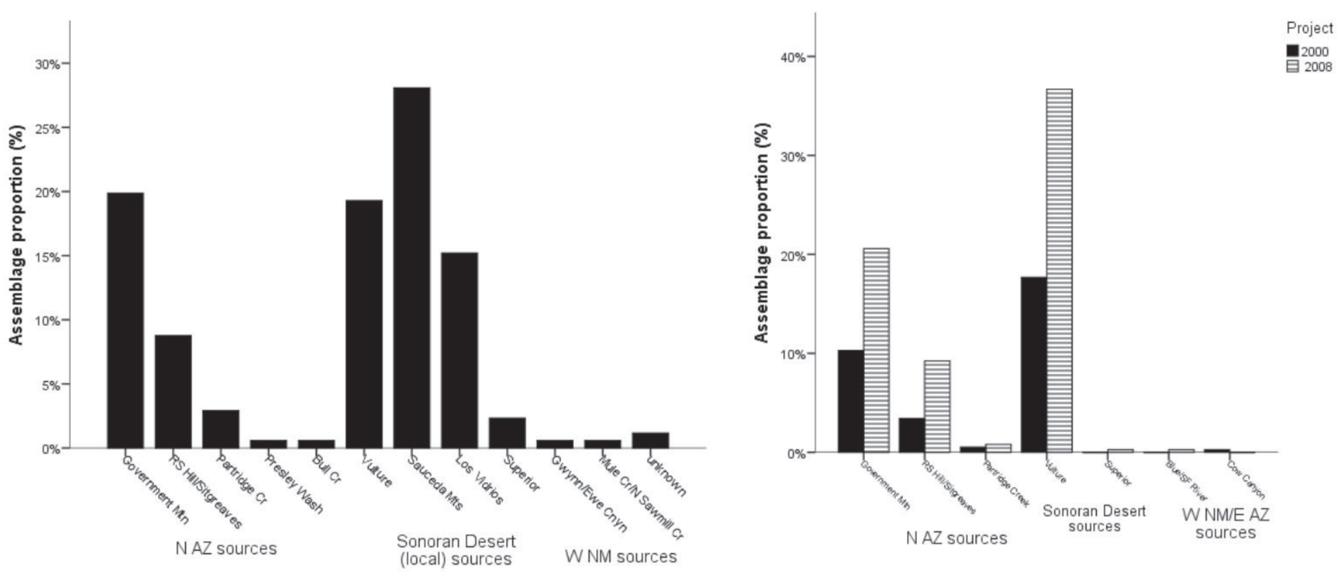

Figure 3. Frequency distribution of obsidian provenance at Las Colinas (A, left; n=176), and Palo Verde Ruin (B, right; n=381) in the Phoenix Basin. Note the dominance of Sonoran Desert sources, particularly Sauceda Mountains, at Las Colinas, absent from Palo Verde Ruin (see text discussion). The proportion of Coconino Plateau sources at both sites is nearly equal, however. At Palo Verde Ruin, the 2000 analysis was mainly obsidian projectile points, and the 2008 analysis included obsidian cores and debitage. The similar provenance distribution of debitage and projectile points suggests that many, if not most, of the points were produced on site (see Marshall 2007; see Figure 4 here).

2011; Watts and Ossa 2016). The archaeological and historical evidence of Preclassic Hohokam potential warrior sodalities apparently survived among the River Yumans and their close kin, the Kumeyaay, with well-developed warrior sodalities recorded on contact (Bee 1963; Forde 1931; Kroeber 1925; Kroeber and Kroeber 1973).

Palo Verde Ruin stands out from other Phoenix Basin Preclassic sites because of the projectile point styles and mix of obsidian sources represented in the projectile point assemblage (Hackbarth and Craig 2007; Marshall 2007; Shackley 2005:161-171). Unlike the other two "traditions" in the Hohokam core, obsidian artifacts in Lower Salt Valley Phoenix Basin sites are produced up to 50% from sources on the Coconino Plateau over 200 km north (Shackley 2005: 161-164; Figures 2 and 3 here). The obsidian points made along the Middle Gila portion of the Phoenix Basin, including Snaketown and Grewe (Hoffman's Santan Tradition), and Gila Bend, including the Gatlin Site (Hoffman's Gatlin/Citrus Tradition), are mainly produced from sources that are closest to the sites conforming to distance-decay expectations (Doyel 1996, 2008; Shackley 2005). While it is apparent that different obsidian exchange networks were present in the Lower Salt with strong connections to the Cohonina, the probable ancestors of the Patayan/Yuman Havasupai on the Coconino Plateau, this exchange network is starkly evident at Palo Verde Ruin (see Hackbarth and Craig 2007; Marshall 2007; Schroeder 1975; Shackley 2005, 2019)[2].

A comparison of Hoffman's (1997) projectile point typology against obsidian source provenance at Palo Verde Ruin, Cohonina style projectile points, local So-

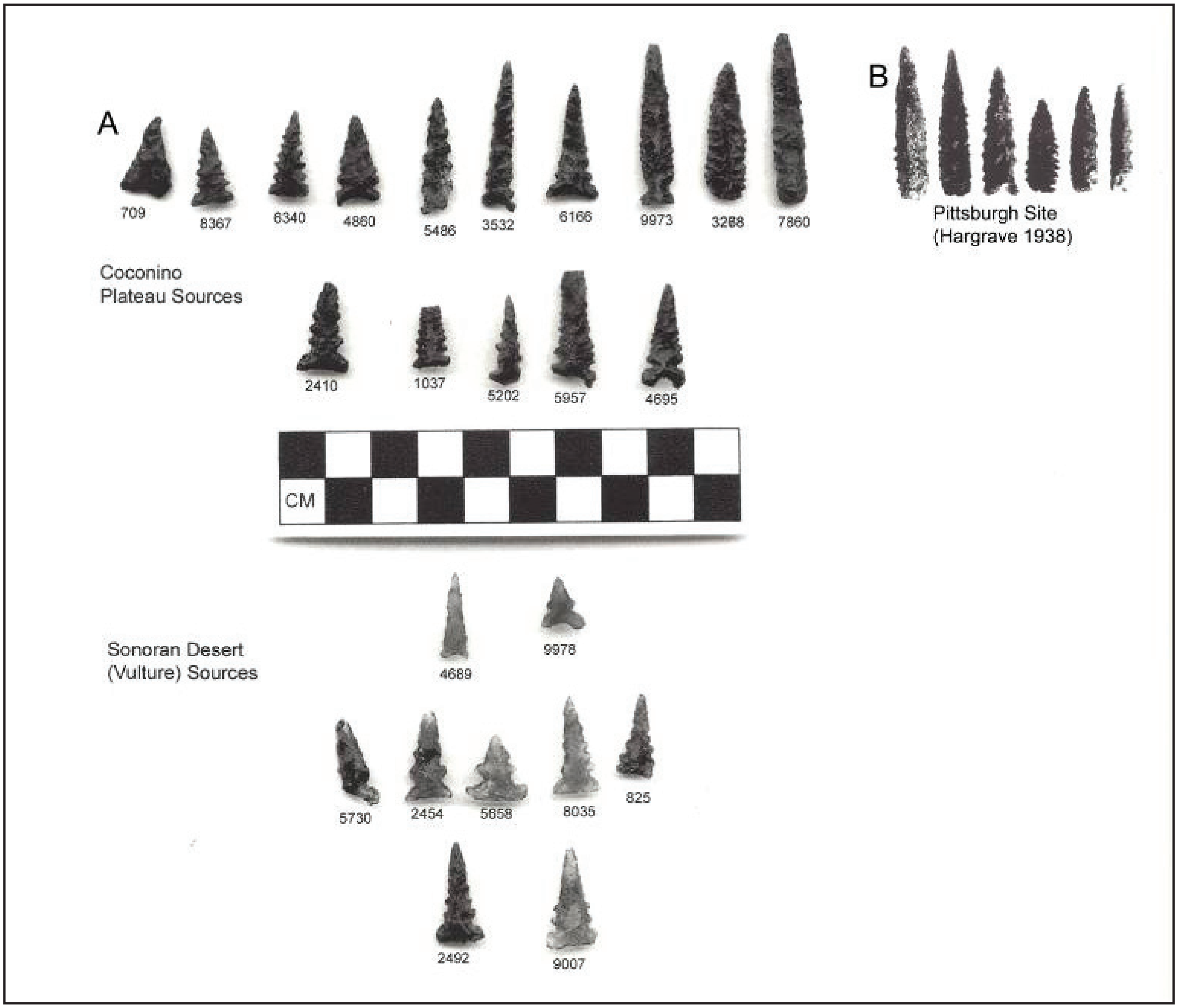

Figure 4. Selected obsidian projectile points from Palo Verde Ruin based on the Hoffman (1997) typology (A left) and the obsidian projectile points from the Cohonina Pittsburgh Site near Williams on the Coconino Plateau (B right) (Hargrave 1938), classified as "Type 8" by Marshall (2007).

lares Style local points that were produced from Coconino Plateau obsidian, is particularly illuminating (Figures 1 through 4). The Cohonina styles often have convex-base haft elements that appear nowhere else in the Phoenix Basin (Hoffman 1997; Loendorf and Rice 2004; Marshall 2007; Shackley 2005). Indeed, they are morphologically identical to those recovered by Hargrave in the 1930s from the Cohonina Pittsburgh Village on the Plateau (Hargrave 1938; Shackley 2005; Figure 4 here). Marshall (2007), in his analysis of the projectile points at Palo Verde Ruin, also recognized their distinctive morphology. Like the Patayan ceramic wares at Las Colinas, these Cohonina obsidian projectile points were all recovered from pithouse contexts in three residential areas of the site, including those with Patayan and other Coconino Plateau ceramic types (Hackbarth and Marshall 2007:69-126; Marshall 2007:152). Other side-notched projectile point styles at Palo Verde Ruin could be either Cohonina or Hohokam, but many are produced from Plateau obsidian sources, mostly Government Mountain (Shackley 2005:167-168; Figure 4 here).

Palo Verde Ruin exhibited unique pithouse architecture similar to Coconino (Cohonina) Plateau forms. Residential Area H "was slightly more elaborate than other habitation areas" (Hackbarth and Marshall 2007:105). In addition to the larger house sizes and "true pithouse" construction (as opposed to typical Hohokam house-in-pit construction), bighorn sheep cranial remains and articulated segments were more common, possibly transported by Cohonina from the north (Hackbarth and Marshall 2007:105). Perhaps significant with regard to the presence of Cohonina was that this residential area was closest to the ballcourt, possibly indicating a Cohonina ball "team" in residence. "Intrusive" ceramics from the Plateau including Black Mesa Black-on-white, Prescott Black-on-white, San Francisco Mountain Gray Ware, and Tusayan White Ware were particularly common in Residential Area H. Excavators found the "Type 8" Cohonina obsidian points throughout Residential Areas C, F, J, and K, but not in Residential Area H that had a high proportion of Plateau ceramics and Cohonina style pithouses. More Plateau Black-on-white pottery occurred in the Residential Area H cemetery than in any other cemetery on the site, however (Hackbarth and Marshall 2007:105). In Residential Area H, the proportion of Coconino Plateau obsidian was greater than Vulture obsidian, the source just to the west of the Phoenix Basin, and the source nearest Palo Verde Ruin (Marshall 2007; Shackley 1995, 2005; see Figures 1 and 2 here). Cohonina and/or Patayan ceramics were present at Palo Verde Ruin overall as well, although not in a circumscribed area as at Las Colinas. Paddle and anvil Tizon Brownware present at Palo Verde Ruin is a distinctive type produced from residual clays by the Patayan/Cohonina/Yumans from central and northern Arizona to the San Diego/Tijuana coast (Davis 1928; Rogers 1936; Shackley 1981, 1984; Van Camp 1979; Waters 1982; Walsh 2007).

While the occupational history of the Cohonina at Palo Verde Ruin is somewhat less distinct as the Patayan at Las Colinas, it appears unambiguous. Due to the Plateau style projectile points, high proportion of Coconino Plateau obsidian sources and the "notable presence" of Coconino Plateau ceramics, archaeologists see the Palo Verde Ruin as the Coconino Plateau "gateway" to the Lower Salt (David Abbott, personal communication 2016; Hackbarth and Craig 2007; John Marshall, personal communication, 2017; Shackley 2005).

At Palo Verde Ruin archaeological evidence of Cohonina presence includes:

- Cohonina style points produced from Coconino Plateau obsidian sources
- A high proportion of Plateau obsidian throughout the site
- Cohonina style pithouses in Area H with a predominance of Cohonina/Patayan Plateau pottery with a dominance of Plateau obsidian sources

Given this evidence it seems reasonable that there was a substantial and likely long-term presence of Cohonina at Palo Verde Ruin similar to the Patayan at Las Colinas, some of which could be ancestors of the upland Yuman Havasupai, Walapai, or Yavapai.

PATAYAN/HOHOKAM MATERIAL CULTURE AND SOCIAL CONVERGENCE

I suggest here that the descendants of the Patayan—particularly the Quechan, Mohave, Kumeyaay, and probably Cocopa—are probable Hohokam/Patayan descendants based on material culture similarities and lifeways, and Cohonina Havasupai and probably other upland Patayan groups (i.e. Walapai and Yavapai) were as well. A simple trait list of material culture similarity between the Preclassic Hohokam and the Patayan is a somewhat outdated culture historical view of prehistory. However, it has been invoked recently to examine the relationship between the Hohokam and O'odahm (Loendorf and Lewis 2017:125), and can act as a springboard to the interpretive endeavor (Clarke 1978; Harris 1968; Schiffer 1976; Thomas 1983; see Jennings and Waters 2014). Following is an inventory of Patayan and Hohokam corresponding material and socio-culture traits derived from the literature and archaeological research on both sides of the Colorado (see also Hicks 1963; McGuire 1992; Schroeder 1975; Shackley 1981, 1984, 2004; True 1966, 1970; Van Camp 1979; Waters 1982).

Material culture similarities include:

- High proportion of exaggerated length side-notched projectile points, locally called variants of Desert Side-notched, and serrated projectile points often mortuary offerings in primary and

secondary cremations (Baumhoff and Byrne 1959: McCown 1945; McDonald 1992; True 1966, 1970; see Figures 5 and 6 here)
- Exclusive paddle and anvil ceramic production (Beck and Ferguson 2016; Davis 1928; DuBois 1907; Heye 1919; Rogers 1936; Shackley 2004; Van Camp 1979; Waters 1982).
- Red-on-Buff ceramic production (Rogers 1936; Shackley 2004; Van Camp 1979; Waters 1982)
- Coffee bean eye decorated ceramic vessels, scoop handles, and figurines both Tizon Brownware and Lower Colorado Red-on-buff forms (Hedges 1973; Rogers 1936; True 1957; Van Camp 1979)
- Zoomorphic and anthropomorphic ceramic vessels (Davis 1928; Hedges 1973; Rogers 1936; True 1957; Van Camp 1979)
- Cremation remains secondarily deposited in ceramic vessels with *Laevicardium* shell or ceramic bowl caps (see Davis 1928; DuBois 1908; Heye 1919; McGuire 1992: Table A.2; McCown 1945).
- Grave offerings in primary and secondary cremations in addition to exaggerated length projectile points: bone hairpins, ceramic and stone effigy figures, groundstone, non-projectile point chipped stone, plummets (DuBois 1907; McCown 1945; True 1970)
- *Glycymeris* shell bracelets and rings, *Haliotis* and *Olivella* beads (McDonald 1992; Schroeder 1975; Shackley 2004; True 1970)
- Steatite and ceramic arrowshaft straighteners, often decorated in geometric patterns and frequently included in primary and secondary cremations (Luomala 1978; Schroeder 1975; Shackley 2004; True 1970)

Cremation practices, as discussed above and based on the burial architecture, included grave goods; and the character of primary and secondary cremations are very similar between the Preclassic Hohokam and Patayan/Yuman, particularly the Kumeyaay (DuBois 1907,1908; McGuire 1992; Schroeder 1975; True 1970; Wilcox and Sternberg 1983). Additionally, McGuire (1992) and more recently Shackley (2004, 2005, 2019) have suggested that much of Hohokam and Patayan social organization was similar based on these parallels in material culture, agriculture, and burial practices. Particularly among the agricultural River Yumans (Cocopa, Quechan, Mohave and the Kamiá or Eastern Kumeyaay of Imperial Valley) multi-layered heterarchical levels of authority among the men was dominant (Bee 1983; Forde 1931; Gifford 1931; Hicks 1963; Kroeber 1925; Kroeber and Kroeber 1973; Spier 1923; Williams 1973, 1983; Wright and Hopkins 2016). While the Yuman societies were loosely ruled overall by the clan or moiety chiefs, sometimes women, much of male society was organized around warrior sodalities, headed by a *kwanamí* (“brave man”; Bee 1983, 1989; Forde 1931; Hicks 1963; Kroeber and Kroeber 1973). This can be seen as a remnant of the warrior sodalities suggested by Hohokam projectile point style and obsidian source provenance patterns discussed above (Hoffman 1997; c.f. Loendorf 2010, 2012; Loendorf and Rice 2004; Shackley 2005;).

One aspect of material culture that is especially relevant is the dominance of side-notched projectile points produced by the Kumeyaay, many stylistically identical to those produced in Hoffman’s Gatlin/Citrus Tradition in the Gila Bend area on the territorial boundary of Patayan and Hohokam (Doyel 1996; Hoffman 1997; Shackley 2004, 2019; True 1970; Wasley and Johnson 1965; Figures 2, 5 and 6 here). These side-notched points are not as common in Preclassic Hohokam sites in the two areas to the east in the Phoenix Basin and Middle Gila, and often when recovered in those areas, are produced from obsidian sources to the west (i.e, Sauceda Mountains), sources on the territorial boundary of Patayan and Hohokam as discussed above (Hoffman 1997; Loendorf 2010, 2012; Loendorf and Rice 2004; Shackley 2005; see Figure 2). In southern California, side-notched points, often called Desert Side-notched, while dominant in Kumeyaay late prehistoric sites, were rarely produced by Takic (Shoshonean) groups just to the north of the Kumeyaay as observed by True (1966, 1970) and others (Baumhoff and Byrne 1959; McDonald 1992; Shackley 2004, 2019). Was this side-notched point style as much a Patayan style as a Hohokam style, and/or the dominance of this style among Gila Bend Hohokam actually due to continual relationships between the Patayan and Hohokam or continual Patayan residence at these sites? Side-notched points so dominant among the Kumeyaay in southern California and northern Baja California could be a result of the Kumeyaay as descendants of the earliest Patayan who moved to the west, first to the Lake Cahuilla shoreline, then on to the San Diego coast. While this appears somewhat speculative on face value, the material culture signature is readily apparent.

Material culture similarities, very similar disposal of the dead, probable linguistic similarities, and strong evidence that Hohokam and Patayan/Cohonina co-resided in the same settlements, indicates a very strong relationship between these two groups. We will never know for certain whether the Patayan/Yuman and Hohokam saw themselves as affinal or consanguineal kin or spoke a dialectically equivalent language, but the Patayan and their descendant Yuman groups retained elements of the Preclassic Hohokam lifeway at many levels and carried those elements all the way to the Pacific coast. A broad DNA study of modern O’Odham and Yuman descendant groups and Hohokam individuals could potentially illuminate this issue.

It seems that the Phoenix Basin and Gila Bend Hohokam welcomed the Patayan/Cohonina even to the extent of living peacefully with them. Patayan/Yuman material culture and lifeway, including mortuary practices, and probable social organization, meet the expectation for a Hohokam descendant group. The archaeological evidence points strongly toward the Yuman groups, particularly the Riverine Yumans and Kumeyaay to the west.[3]

Notes

[1] **Projectile point typology**. With respect to point typologies in the Southwest, particularly as it applies to the Hohokam, there are multiple schemes (Hoffman 1997, Loendorf 2012; Loendorf and Rice 2004; Marshall 2007; Shackley 2005). Most use a metric typology easily compared across assemblages. I use Hoffman's typology here because I analyzed the source provenance of the obsidian points from many of the collections he analyzed for his dissertation (Shackley 2005).

The Kumeyaay point typology is very much based on Great Basin styles as discussed by McDonald (1992), although as observed early by True (1970), the Desert Side-notched style very similar to the Gatlin/Citrus Tradition points in the Hoffman typology is restricted to the Kumeyaay in southern California, and was rarely produced by the Takic (Uto-Aztecan) groups of southern California (1970:47-48). True observed that the side-

Figure 5. Late Prehistoric (ca. A.D. 1200-1769) Kumeyaay projectile points from throughout San Diego and Imperial Counties, California (from Shackley 2004, 2017, 2019). Note the dominance of side-notched points, all similar to Sauceda Side-notched and other side-notched point styles produced mainly in Hoffman's Gatlin-Citrus Tradition Preclassic Hohokam area (Gila Bend), typical of prehistoric Kumeyaay assemblages (Hoffman 1997; see also McDonald 1992; True 1970). The obsidian projectile points are all produced from the Obsidian Butte source located in south-central Imperial County, California, about 90 km west of the Colorado River, a source that was under Lake Cahuilla during the five to six high stands of the lake, then exposed during dry intervals and permanently after A.D. 1700 (Hughes and True 1985; Shackley 1984, 2017, 2019; Waters 1980, 1982; see Figure 1 here). Scale in centimeters.

Figure 6. Desert Side-notched projectile point styles from CA-SDI-4520, the historic Kumeyaay village of Matamó, south central San Diego County. Many of these styles are identical to those from the Gila Bend Preclassic sites such as Gatlin and Citrus including the keyhole notching technique of Hoffman's Gatlin and Citrus Traditions (Hoffman 1997). Most are produced from the local Santiago Peak rhyolite (Shackley 2017). The obsidian points are all produced from Obsidian Butte (see Figure 1; Shackley 2019). Compare the long, serrated side-notched point in the center to those from the Gatlin Site at Gila Bend figured in Wasley and Johnson (1965:100) and many others from the Citrus Site (1965:105). Scale in centimeters.

notched forms from sites in the Peninsular Range of San Diego County, particularly the long, serrated types were similar to "Sacaton phases of the Hohokam in considerable numbers" (1970:46), including Valshni Village in southern Arizona (Withers 1941). As noted above, True also observed the similarity in prehistoric Kumeyaay material culture and Hohokam material culture in that study including coffee bean eye ceramic figurines as well as point styles and burial customs (True 1957, 1970).

[2] **Cohonina and Patayan**. It is beyond the scope here to examine the cultural relationship between the Cohonina and Patayan. Schroeder considered them both part of the western and northern Arizona Hakataya, and by AD 1750 the Cohonina became what is now known as the Patayan/Yuman group the Havasupai (1957, 1975, 1979). McGuire (1982) sees Schroeder's *Hakataya* as too inclusive and incorporates too much diversity. The Cohonina as ancestral to the Havusupai, a Yuman lan-

guage group, seems rational, however, and supported by the Havasupai themselves. Harner, who worked in a number of sites both above and below the Coconino Plateau, considered the Cohonina ancestral Patayan (Harner 1938). Whether the Cohonina at Palo Verde Ruin saw themselves as part of a larger Patayan society is, of course, unknown; but material cultural similarities between the Hohokam, Cohonina, and Patayan including ceramic technology (paddle-and-anvil), projectile point styles, and western Arizona obsidian sources suggest the probability that the Cohonina and Patayan are one cultural entity in a general sense and probably in the particular. This is my perspective based on this and other research (see Hargrave 1938; Schroeder 1975:112-124; Shackley 2019).

[3] **Hohokam and O'Odham**. Randy McGuire argues that we need to divide up what we have called Hohokam (personal communication, 2017). Where he works in Sonora and in southern Arizona (Papaguería and Tucson Basin) he sees good evidence for a massive population decline at about AD 1450, but with cultural continuity into historically known O'Odham. This is "seen" in Sonora and in southern Arizona with the so-called Sobaipuri and Whetstone Plain, which develops in the Altar Valley, Sonora into known Tohono O'odham wares. We both agree that based on archaeological evidence, the Phoenix Basin Hohokam were ancestral to Yumans, but McGuire suggests that the southern Arizona Hohokam were ancestral to O'Odham. Additionally, cremation continues as the dominant burial practice in both the Tucson Basin and Trincheras (and Yuman) as opposed to Phoenix Basin and Tonto Basin where inhumations are much more common late.

While a "northern/southern" split within Hohokam society and consequent history is untested, the observations of McGuire, as well as Jeff Clark, point to the multiethnic composition of Hohokam society as a whole.

Acknowledgments. The inferences herein are mainly my own generated from decades working on both sides of the Colorado River, although many others have influenced my thinking. I thank Jeff Clark, John Marshall, and Dave Abbott for the numerous discussions we've had over the years about Hohokam prehistory, migration, lithic technology, and obsidian source provenance, as well as more recently Aaron Wright. Randy McGuire offered excellent ideas about the differences between the "northern and southern" Hohokam, and influenced my thinking, as well as reviewed this essay for the journal. Glen Rice prodded me to put my thoughts and experience on paper. Thanks also to an anonymous reviewer who modified my thinking, and Doug Mitchell who served as journal editor. My thanks to Ana Sandoval of the Sycuan Band of the Kumeyaay Nation for teaching me to try to speak and understand *Ti'ipay AA* as a grad student at SDSU, and understand growing up in *Hemechaa* (Jamacha). You have forever shaped my understanding of humans. *Nya'amah*

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GRANARY PEDESTALS: STORAGE FEATURES FROM THE HINTERLANDS AT A CLASSIC PERIOD PLATFORM MOUND IN THE HOHOKAM CORE AREA

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ABSTRACT

Recent excavations at the Lower Santan Platform Mound in the Gila River Indian Community (GRIC) identified three unusually large circular rock and adobe features on the floor of an exceptionally large room within the mound compound. These features have been referred to as "pedestals" and they appear to be the bases of beehive-shaped adobe grain storage facilities. These distinctive features have not been previously identified within the GRIC, but they are common in some peripheral areas including the Tonto Basin, along the San Pedro River, and in some portions of Northern Mexico. Given their nature, these features are not likely to have been emulated for stylistic reasons, and instead they more likely reflect differences in the cultural traditions of the makers. This suggests the pedestals may be evidence for close relationships, including immigration, between the Phoenix Basin and other areas. Historical documentation, ethnographic evidence, and oral traditions support this possibility.

INTRODUCTION

Preserving and storing food are essential activities for all societies (Binford 1980; Laland and O'Brien 2010; Testart 1982). In particular, storage features are designed to protect resources from environmental dangers such as rodents, insects, moisture, bacteria, and fungi, as well as other humans. Much of the previous archaeological research regarding storage has focused on the role of surplus goods in the development of complex societies, including increased social stratification and economic specialization, particularly in the Neolithic Near East (see for example, Blanton 1998; Earle 1997; Flannery 1972; Fried 1967; Service 1962). For the Akimel O'Odham (i.e., Pima) and other Native Americans in the Southwestern deserts, storage was also essential, but evidence shows that it occurred largely at the household level (Russell 1908). However, atypically large storage features that were recently discovered at Lower Santan platform mound village along the Middle Gila River (Figure 1) show that specialized containers for foodstuffs did occur in some contexts, but the storage capacity of these containers do not appear to have been sufficient to support the entire community along the Santan canal. Instead, it appears more likely that the storage facilities are related to special activities undertaken at the mound, such as ceremonies involving feasts (Rice 1998).

The pedestals were identified as part of investigations completed by the Cultural Resource Management Program (CRMP) of the Gila River Indian Community (GRIC). The excavations were conducted in advance of a home construction project that overlapped the compound of the Lower Santan Platform Mound (GR-522). Similar features have only rarely if ever been previously identified within the Phoenix Basin. The three granaries are also notable for their atypically large size and location within an area that had restricted access. This paper describes the Lower Santan pedestals and considers the implications of their nature and socioenvironmental context. It appears that the features may have been influenced by hinterland populations, or possibly were built by immigrants from areas surrounding the Phoenix Basin.

SITE DESCRIPTION AND SETTING

GR-522, also known as Lower Santan Village, is a large multi-component site that includes an extensive prehistoric Hohokam platform mound village and the remains of numerous smaller prehistoric and historic habitation areas that have been disturbed by modern agricultural activities into a continuous artifact scatter (Loendorf et al. 2007; Loendorf et al. 2009; Neily et al. 1999). The site extends approximately 2.4 kilometers (1.5 miles) along both sides of State Route 87, east of

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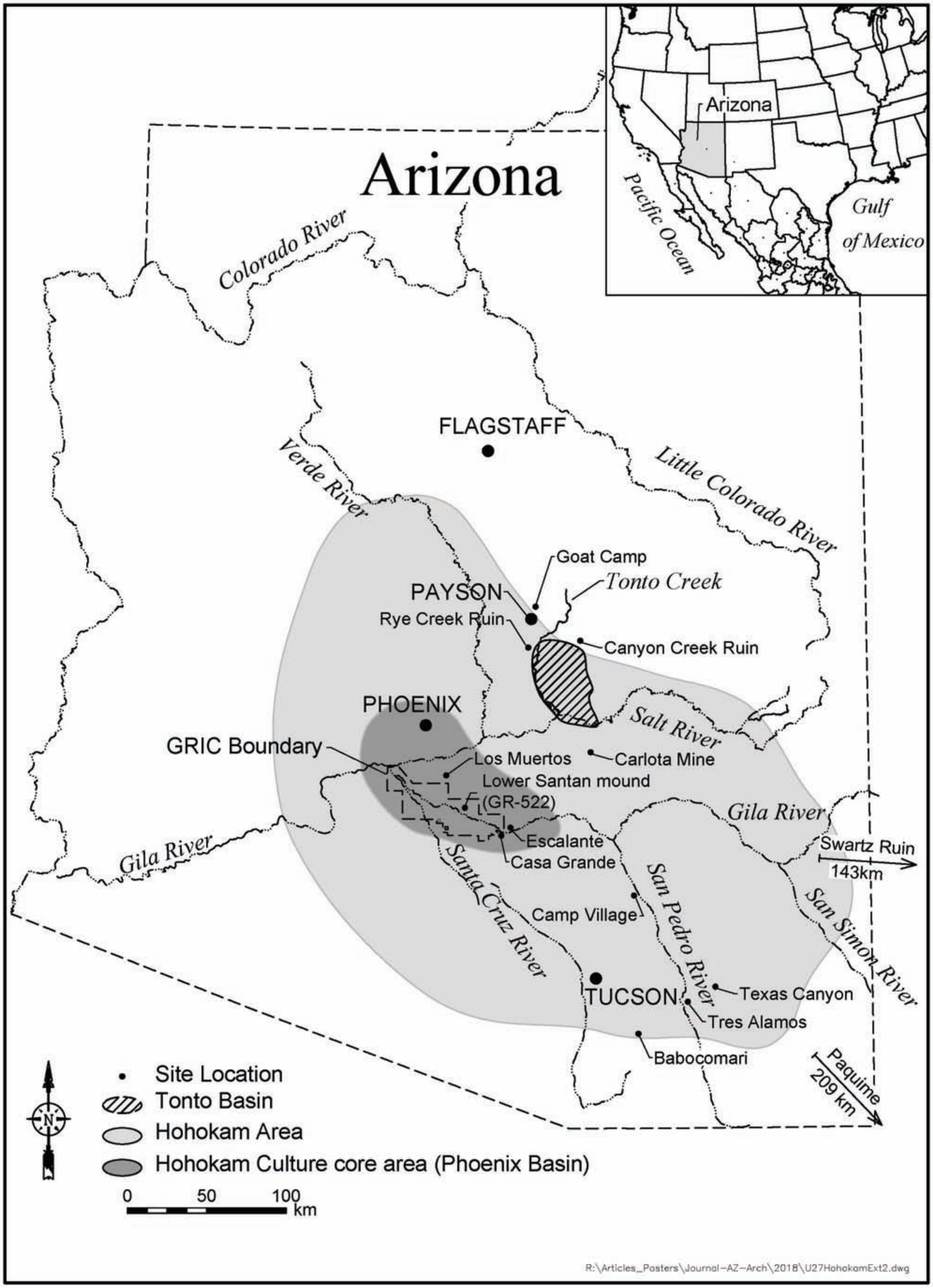

Figure 1. Map showing locations mentioned in this paper.

the modern village of Stotonic, with the Lower Santan Platform Mound situated near the northwestern extent of the site (Figure 2). Located on the north side of the Gila River, near the terminal extent of Santan Mountain bajada, the site encompasses approximately 306 hectares (756 acres) in District 4 of the GRIC. The site is divided into 17 loci, defined primarily by arbitrary boundaries such as roads, canals, and modern agricultural fields. The eastern edge of GR-522 shares an arbitrary boundary with the western extent of Site GR-441, which includes the Upper Santan Platform Mound.

Diagnostic artifacts from GR-522 show that use of the area began at least during the Middle Archaic period (ca. 5000 B.C.) and extended through the late Historic Period, but habitation features at the site reached their maximum extent in the Hohokam Sedentary Period around A.D. 1050. The pedestals at the site were located within the platform mound compound (in Locus D), which dates to the Classic period when habitation areas at GR-522 substantially decreased in both size and density (Woodson 2010, 2016).

Frank Russell (1908) provided the first written account and photographs of the Lower Santan site. He also reported that *Tcui'haowo-o*, or Dipper, was the former chief of the platform mound (Russell 1908:24). Frank Midvale, who was working at the time for the privately-funded Gila Pueblo Archaeological Foundation, first mapped the site in 1928. His description includes a "sun temple" (probable ballcourt), one large compound (platform mound), two smaller compounds, two roasting pits, and 37 trash mounds, some of which were described as "gigantic" in size. The site was recorded by Gila Pueblo as site Gila Butte 3:7 (Mitalsky 1928) and was documented again in 1959 as AZ U:13:6 (ASM) by Woodbury and Wasley (Wood 1972; Woodbury and Wasley 1959). Many of the surface features, including the ballcourt, had been obliterated prior to these later surveys by modern agriculture and various infrastructure projects. GRIC-CRMP recorded the site as GR-522 in 1996 during survey for the Pima-Maricopa Irrigation Project (P-MIP; Neily et al. 1999).

The northern half of GR-522 (Loci A, C, D, E, F, T, U) encompasses the highest density habitation areas that have been identified to date at GR-522 (see Figure 2). Within this portion of GR-522, GRIC-CRMP has conducted over 10 kilometers of Phase I Data Recovery test trenches, and completed large horizontal exposures covering a total of 31,160 square meters (CRMP Project Files; Brodbeck and Neily 1997; Loendorf and Woodson 2008; Plumlee et al. 2014; Woodson and Loendorf 2008). This work has substantially improved our understanding of the Lower Santan settlement area, and resulted in the identification and sampling of over 2,600 cultural features including more than 100 inhumations and 200 cremations. Data Recovery investigations have identified more than eight elongated habitation areas that extend along the low ridges between washes that drain upland areas to the northeast. Large reservoirs have been found in association with most of these habitation areas in this portion of the site, and evidence also exists for small ditches that fed these water catchments.

This northern portion of the site is also where both the probable ball court and platform mound are located. Ceramic and other data indicate that this location was settled in the Early Colonial period, when the Santan Canal was extended into the area (Woodson 2010, 2016). The site grew into a large village during the Sedentary period, when it covered at least 28 hectare (70 acres), but by the late Classic period only a series of much smaller and dispersed compounds existed in the area. Woodson (2010, 2016) calculated settlement sizes based on the extent of residential areas using population density ranges between 10 and 20 persons per ha (see Craig 2000; Kowalewski et al. 2004). Using this method, the pre-Classic population of the northern portion of GR-522 was estimated to be between 700-1400 people, whereas the Classic period settlement remaining at the platform mound was estimated to have dropped dramatically to only between 166 and 362 people. However, several much smaller habitation areas remained during the late Classic period in areas to the southwest in Locus U and southeast in Locus A (CRMP Project Files; Brodbeck and Neily 1997; Loendorf and Woodson 2008; Plumlee et al. 2014; Woodson and Loendorf 2008).

PEDESTALS AT LOWER SANTAN PLATFORM MOUND

Archaeological excavations were completed by GRIC staff near the northwest corner of the platform mound as part of a tribal home site project on allotted lands. The investigation was restricted to the footprint of the proposed home location. Approximately half of the project area was inside the mound compound, while the other half was immediately outside the compound wall. Several prehistoric rooms were identified, including one large adobe structure (Feature 1918; Figure 3) where the remains of three storage features were located. The features consist of adobe and rock pedestals that previously have been called "granaries."

Feature 1918 is an exceptionally large adobe pit room that is approximately 7.5 meters wide and 13 meters in length with the long axis running north-south. The structure is located immediately adjacent to and within the compound wall for the Lower Santan Platform Mound, and was separated by a narrow gap. Other features in the vicinity include two pit rooms (Features 1915 and 1922) that predate Feature 1918 (see Figure 3). Feature 1922 was heavily disturbed by the construction of the compound wall, while Feature 1915 was largely outside the project area and therefore was not fully excavated.

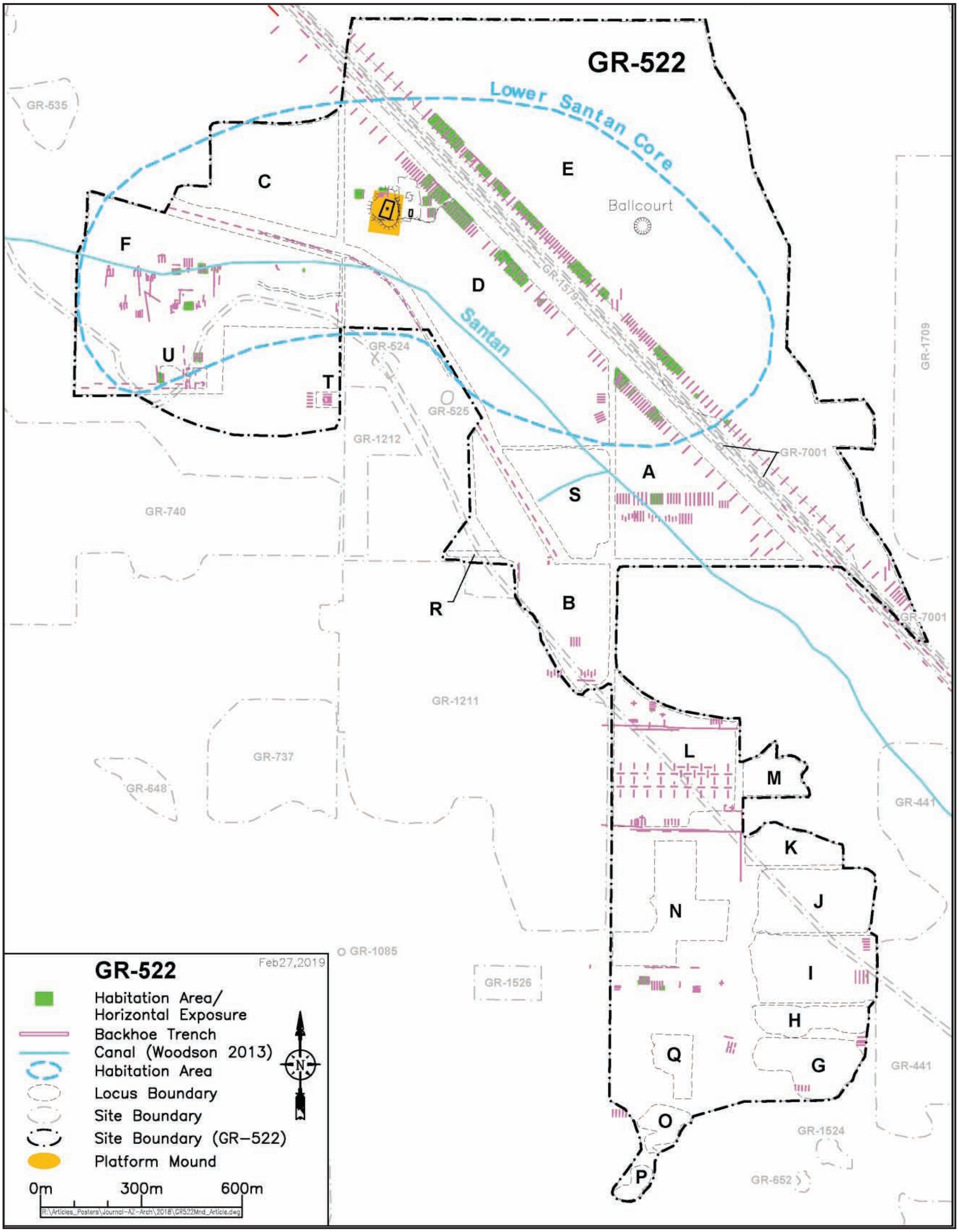

Figure 2. Map of GR-522 (Lower Santan Village), showing excavations, features, and neighboring sites.

The structure also has unusually substantial adobe walls that vary between 30 and 60 centimeters in thickness. Much of the floor space within the room was occupied by three circular pedestals made from adobe and cobbles, some of which were fragments of schist (Figures 4 and 5). Because all investigations were restricted to the footprint of the new home location, only 60 percent of the room was excavated, and it is possible that one or more additional pedestals may be present in the uninvestigated portion.

The pedestals appear to be basal portions of beehive-shaped adobe storage features. The rock and adobe base would have functioned to help prevent rodents or other animals from burrowing into the storage features from below. Comparatively well-preserved examples from the Tonto Basin suggest that the walls were formed from a basketry framework that was covered with adobe (Lincoln-Babb and Jacobs 1990) The pedestals were constructed directly on the floor of Feature 1918. The features are all similar in size, and they average 1.85 m in diameter. A reconstruction of the appearance of the Feature 1918 granaries is shown in Figure 6.

No post holes were identified within the structure, and there is no evidence for roof support beams. Combined with the large size of the space defined by the walls, this suggests that the structure either had an insubstantial roof or lacked one altogether. While it was not fully excavated, the room also appears to have lacked a hearth, and it does not appear to have been utilized as a residential space. The three pedestals encompassed over half of the floor area that was excavated, and the room appears to have been dedicated to storage, at least at the end of its use. Radiocarbon dating of one carbonized Zea mays cupule sample recovered from the floor of the room produced a date of 980 to 1035 cal AD, and a second produced a date of 1210 to 1281 cal AD. This suggests that the room was used from the Sacaton through the Soho phases. Given the location along the compound wall, it is surprising that late Classic period remains were not identified within the room, and the ceramic assemblage lacked Salado polychromes.

Pollen samples collected from the pedestals and the floor of the room contained considerable evidence for cultigens and cultivars dominated by maize, but also including cholla, probable saguaro, and squash. Pollen concentrations were greatest in the samples collected from the granaries themselves, which suggests they were employed to store both wild and cultivated foods. The following section summarizes information regarding storage features that were employed by the Historic period residents of the Lower Santan area.

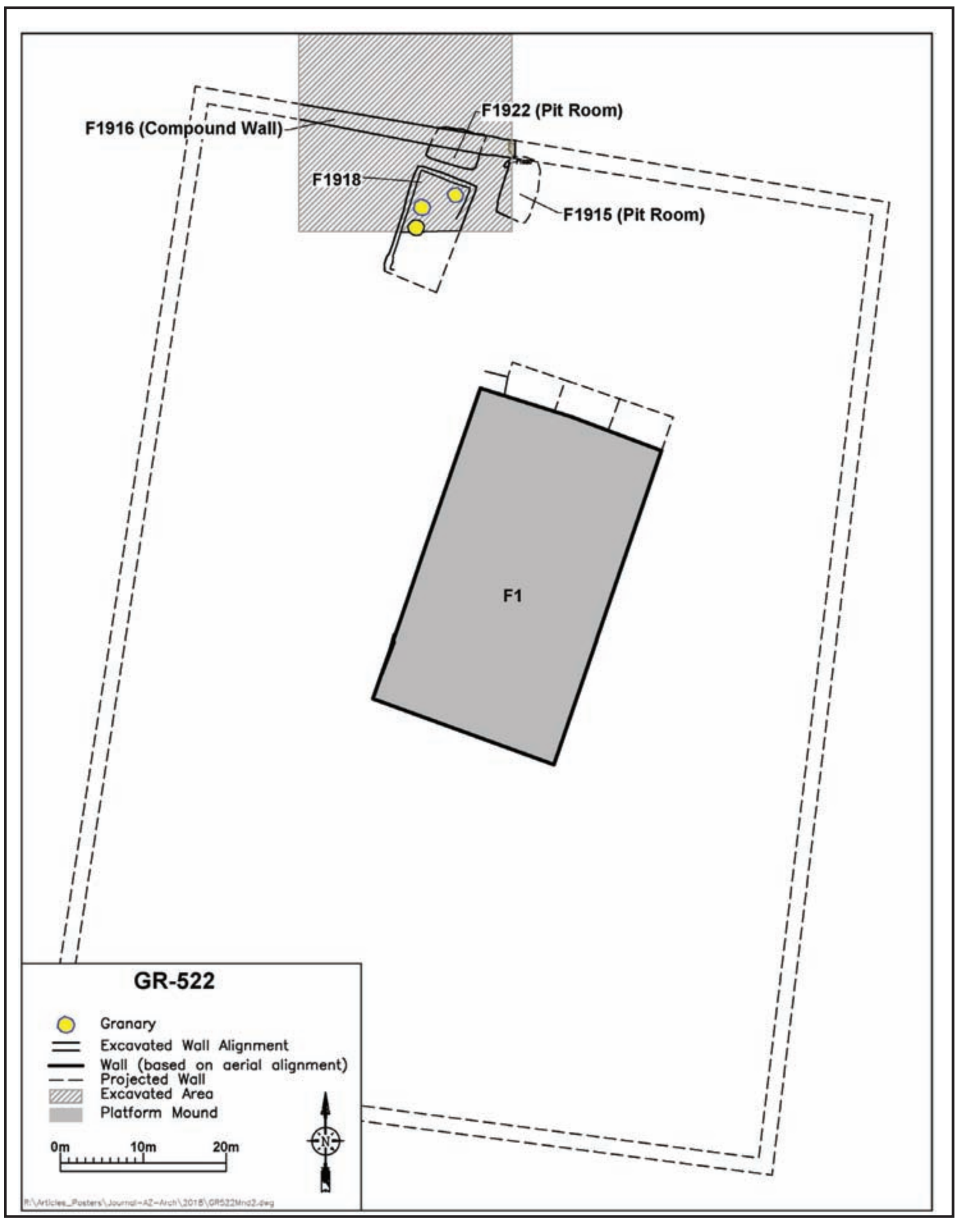

Figure 3. Map of a portion of GR-522 showing the location of Feature 1918 in relation to the Lower Santan Platform Mound.

ETHNOHISTORICAL AND ETHNOGRAPHIC OBSERVATIONS OF FOOD STORAGE FEATURES

Methods employed by preindustrial peoples and their requirements for storage varied in large part based on environmental considerations (Kuijit 2009). Food storage served as a buffer against times when resources were scarce, whether due to short-term and predictable variation (i.e. seasonal availability) or less predictable and longer term processes like drought (Winterhalder et al. 2015). Stored foods also played a role in social relationships through activities such as feasting events (Grimstead and Bayham 2010; Potter 2000) and could enable a community to support non-subsistence specialists, such as craftsmen or religious specialists (Lindauer 1997; Rice 1990).

Ethnographic data indicate that most of the storage features employed by the historical occupants of the Middle Gila River are unlikely to be preserved in the archaeological record. This is in part because they were generally constructed from organic materials that only rarely preserve in contexts outside dry rock shelters. Furthermore, granaries were also often built in contexts where assemblages are rarely preserved. For example, Russell (1908:88) observed that “basket bins on the house tops” or ramadas were a primary method of storage for the Akimel O’Odham (Figure 7). Given their elevated location, these features are likely to have been damaged when the roof collapsed, and therefore not preserved.

Regarding food storage in general, Haury (1976:119) stated that “preservation must have been accomplished mainly by drying and parching, as was done historically by the desert people. Jars and baskets made convenient containers for the storage of seed crops. Small-mouthed pottery vessels were particularly effective because the openings could be sealed to curb invasions by pests.” While ceramic containers were more resistant to water and other disturbances like rodents, large basketry containers were able to hold substantially larger volumes of foodstuffs.

Russell (1908:143) observed that the Akimel O’Odham used two different types of storage baskets.

Figure 4. Feature 1918 with three granary pedestals *in situ* on the floor (10 cm scale). Photograph by Thomas Ross (GRIC CRMP).

These consisted of a "circular bin of arrow bush" with a base of willow branches. The sides, which were built from twisted rolls of arrow bush that were inserted into the underlying coil in order to secure them, are similar to the granary pedestals in that they were "covered with bushes and earth" (Russell 1908:143). These features were generally used for storing mesquite beans on the tops of the houses or sheds (Figure 7). These large baskets were beehive shaped, and rocks were sometimes used in the bases, which is also similar to the prehistoric examples. In other instances, these containers were built on the ground in groups, and were enclosed by a low fence to protect them. This type was made before the harvest began, and as the coils were large and "no close work [was] required a large bin may be built up in half a day" (Figure 8; Russell 1908:143).

The second storage feature type described by Russell (1908:143) consisted of coiled baskets made from wheat straw. These baskets had their coils fastened with strips of willow bark that were about 5 mm in width. The stitches that passed through the upper margin of the last coil were about 20 mm apart, and the coils were from 1 to 2 cm in diameter. These large coiled baskets were from 0.5 to 1.5 meters in height. They were sometimes covered with a circular coiled basketry lid made from the same materials as the sides and base. However, part of the bottom of an old worn-out basket was the most common lid type. During construction of these baskets, two coils were stitched at the same time; but, they were more carefully made, and it took "much longer" to produce them than it did to comparable arrow bush granaries (Russell 1908:143). These baskets were made after the wheat harvest when the construction materials were available (Figures 9-10).

Both of the granary types described by Russell (1908) share similarities with the probable construction method for the granaries in Feature 1918 at the Lower Santan Platform mound. However, adobe coatings were not applied to the Historic period examples, and it would have been necessary to employ wild grasses for the prehistoric granaries because wheat was not available prior to the introduction of the crop by the Spanish. Preserved examples of granaries made entirely from organic materials have not been previously iden-

Figure 5. Partially excavated granary pedestal within Feature 1918 at the Lower Santan Village site (10 cm scale). Photograph by Brett Coochyouma (GRIC CRMP).

Figure 6. Artist conception of the storage room, as it may have appeared while in use. Illustration by Scott Medchill.

tified within archaeological contexts along the middle Gila River, including those from the Historic period (e.g., Loendorf et al. 2018).

PREVIOUS GRANARY PEDESTAL RESEARCH

Despite extensive investigations, granary pedestals have not been found elsewhere within GR-522, nor have they been previously reported for sites on the GRIC. Indeed, despite large-scale excavations, little evidence for any type of granary features has been identified along the middle Gila River, but possible candidates for storage facilities include bell-shaped pits, slab-lined pits, and some other nonthermal pits. In addition, Haury (1976:118) identified a "small hamper made of closely spaced wooden rods" within a Vahki Phase house in Snaketown, but it is unclear if the feature was a granary. Haury (1945) also published a map that shows a possible granary. It was produced by the 1887 Hemenway expedition and displays "Ruins IV and V" from the Los Muertos site, south of the Salt River, in the area of modern Tempe, Arizona. Originally believed to be two separate room clusters, Ruins IV and

Figure 7. Adobe house with granaries on the roof, San Xavier, Arizona (William Dinwiddie 1894; Special Collections, University of Arizona Library).

V were determined to be a single residential compound. The map shows a small interior room with a circle that is labeled "Granary" taking up most of the floor space. No additional information about the feature is available as the map was not accompanied by field notes, and Frank Cushing's unpublished manuscript regarding the excavations does not provide any further details (Haury 1945). Consequently, it is not clear if this is a similar rock and adobe pedestal or some other feature type.

Aside from the possible example described above, adobe and rock pedestals also do not

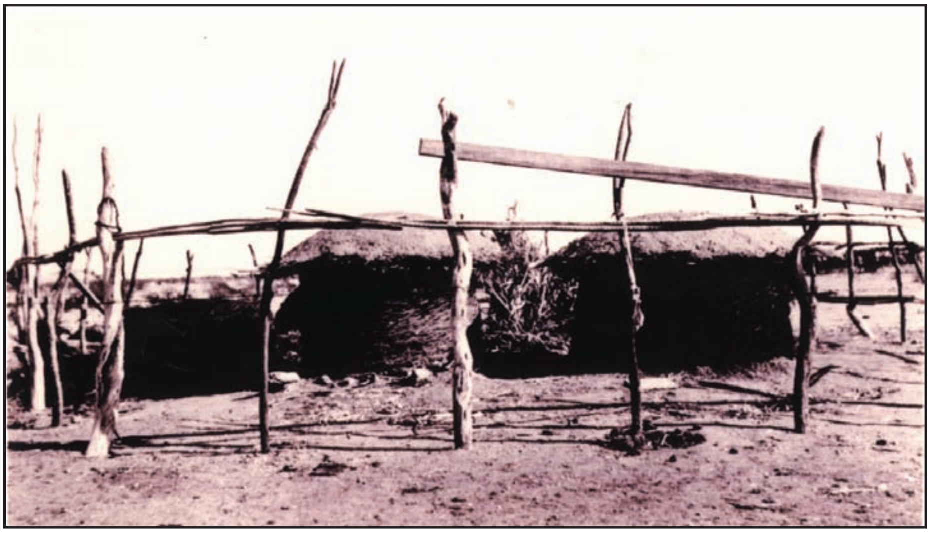

Figure 8. Tohono O'Odham granaries near Topawa, Arizona (Davis 1919).

Figure 9. Akimel O'Odham granaries (Curtis 1907; Edward S. Curtis Collection, Library of Congress).

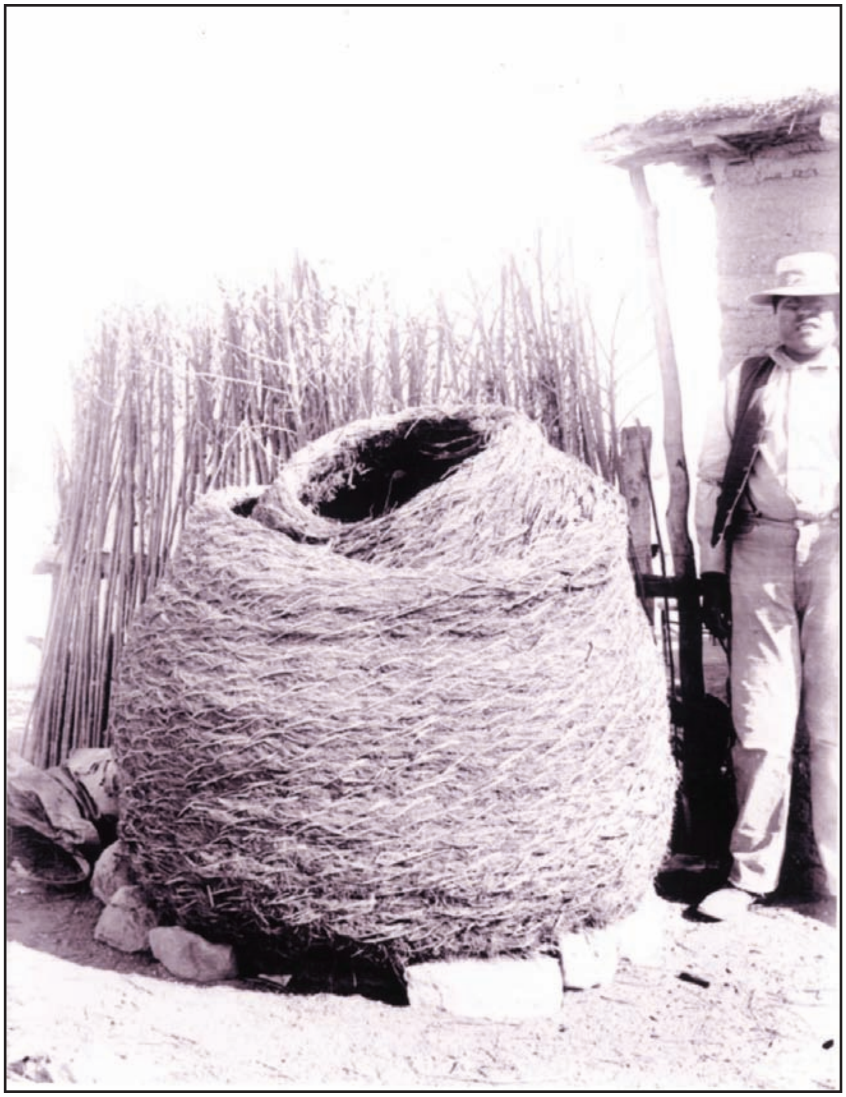

Figure 10. Tohono O'Odham man standing next to a granary on rocks near Fresnel, Arizona (William Dinwiddie 1894; Special Collections, University of Arizona Library).

appear to have been previously identified along the lower Salt River within the Phoenix Basin. However, pedestals are common elsewhere in south-central Arizona and northern Mexico (Table 1). Locations where they have been identified include the Tonto Basin and vicinity, the San Pedro Valley, and Paquimé (Clark and Vint 2004; Lincoln-Babb and Jacobs 1990; Lindauer 1997; Oliver and Jacobs 1997; Rice et al. 1998a; Sanchez 1986; Tuthill 1947).

It is possible that pedestals may be present at some sites that are located upstream from the GRIC along the middle Gila River, and equivocal examples have been reported for Vahki Village (Darling 2009), Compound B at Casa Grande (Fewkes 1913; Spears 1973:17), and the nearby Escalante Site (Brown and Van Dyke 1995; Di Peso 1951; Doyel 1977; Spears 1973). However, these features consisted only of caliche and did not incorporate rock. At Casa Grande, for example, in the corner of a floor of "either a small room or plaza" excavated on "Pyramid B" of Compound B, Fewkes (1913:20) identified a round, flat-topped pedestal of caliche, approximately 0.5 meters in diameter, which he labeled as a "firepit." The examples at Escalante were located within a presumed storage room (Doyel 1975) and had concave depressions which Spears (1973:17) suggests may have served as "pot rests." A similar possible granary feature was recorded at Vahki Village (AZ AA:2:66 [ASM]), south of the Casa Grande Ruins National Monument, near Coolidge, Arizona (Darling 2009). It was poorly preserved but appeared as a small (0.58 m diameter), slightly concave pedestal of caliche with very little associated stone, apparently within a room in an adobe compound. The feature is less substantial than those from Lower Santan, but is similar to the Casa Grande and Escalante examples. Unfortunately, the descriptions of these features lack sufficient details to determine if they served as granary bases, and in each case the excavators interpreted them differently. Consequently, it is unclear if they are similar to the pedestals in Feature 1918 at GR-522.

Haury (1934) recorded a "clay-covered basket" at the Canyon Creek Ruin, on the Fort Apache Reservation, which he interpreted as a granary. He observed the "parallels in technique in the Pima granary baskets of today," and speculated on "whether the technique moved from south to north, or vice versa" To the west, Haury (1930) also recorded the round base of a basketry and adobe granary associated with the platform mound compound at the nearby Rye Creek Ruin (see also Elson and Craig 1992). The VIV Ruin, a large Gila phase site in the Tonto Basin also had a similar granary base within a room at the platform mound compound (Mills and Mills 1975).

Seven granary pedestals were excavated within the courtyard of Compound II at the Tres Alamos site in the San Pedro Valley, Arizona and two more were reported from Babocomari Village (Di Peso 1951). Extramural granaries have also been described along the lower San Pedro River at the Camp Village site (Clark and Lyons 2012). These features appear to be common within the San Pedro Valley, but some were made exclusively from adobe. Other examples are more similar to the Lower Santan Platform Mound, with both adobe and stone. The San Pedro pedestals range in size between roughly 1.57 – 2.03 m in diameter, which will be discussed further below, is similar to the range for extramural pedestals from the Tonto Basin. Eight granary pedestals were also identified just east of the San Pedro at Texas Canyon, by W.S. Fulton (1934). The published documentation for these features is limited, and their context is unclear.

Similar granary features are also found elsewhere in the desert Southwest. Cosgrove and Cosgrove (1932) documented four stone and adobe granaries within plaza areas at the Swartz Ruin, along the Mimbres River in southwest New Mexico. Large adobe granaries have also been reported for rock shelters near Paquimé (Chihuahua, Mexico). However, the Chihuahuan granaries are much larger than the Santan pedestals, and they also lack a cobble base, probably because they were built on bedrock (Lumholtz 1902; Sanchez 1986; Sayles 1936; Shepard 1936).

A large example (approximately two meters in diameter) of a granary platform was recently recorded within a masonry room, at the small Goat Camp Ruin site, near Payson, Arizona (Wood 2017). The feature abutted a wall within what was interpreted as a storeroom and was composed of two layers of tabular stone packed tight with an adobe matrix. Impressions of basketry or matting were found in burnt daub associated with the feature. The distribution of granary pedestals within the Payson area is not well documented, and Charles Redman (1993) commented that "without knowing their significance, excavators … may have failed to recognize these platforms … and recorded them as clusters of stone. A close reexamination of the notes and photographs … revealed … these types of platforms were present [at Risser Ranch Ruin and Shoofly Ruin]."

Two adobe and stone granary platforms were also recorded as part of the Carlota Copper Mine project near Miami, Arizona. Within the corner of a small storage room at the small Classic period (Gila and Roosevelt phase) masonry compound site AZ U:12:58 (ASM), a granary pedestal was documented (Yoder and Zyniecki 2002:431-432, Figs. 23.6 and 23.7). At the larger AZ V:9:262 (ASM), located nearby, a stone and adobe granary platform was also found in the corner of a small masonry room, within the compound (Fox 2002:63, Fig. 3.3).

These previously reported examples have all been associated with adobe compound architecture, and they appear to date to the Classic Period (see Table 1). Numerous granary pedestals have also been documented within the Tonto Basin, and it appears that a strong cultural tradition of constructing adobe and stone bases for storage features existed in this region. However, although similar granaries occur throughout Tonto Basin, they appear to be substantially more common at sites along the Salt River arm, and fewer examples were recorded at sites within the Tonto Creek arm of the basin (Ciolek-Torello et al. 1994; Ciolek-Torrello and Welch 1994; Doelle 1995a, 1995b; Elson et al. 1995; Elson and Swartz 1994; Elson et al. 1994; Fish 1995; Heidke and Stark 1995; Holmlund et al. 1994; Jacobs 1994; Lindauer 1996, 1997; Oliver 1997; Oliver and Jacobs 1997; Rice 1998; Rice et al. 1998a; Rice et al. 2009; Rice et al. 1998b).

Within the Tonto Basin, granary pedestals were associated with both platform mounds and residential compounds. They sometimes occur within both plazas and rooms, and it appears that pedestal location is related to site size, such that pedestals were built in extramural locations at smaller sites, while they occur within rooms at compounds that include more than approximately 12 rooms (Jacobs 1994; Figure 11-12). The size of the of pedestals within the Livingston area of the Tonto Basin also varied by context, and intramural pedestals were on average roughly half the size of those found in plazas (Jacobs 1994). The Lower Santan pedestals are at the upper end of the size range for Tonto Basin examples, and they are by far the largest examples that have been reported from within a structure (Figure 13).

DISCUSSION

The construction of granaries required more effort than simpler methods of storing food such as simply leaving kernels on corn cobs. This labor investment suggests that specialized storage features offered advantages, including dry locations that could be placed in extramural areas where access could have more readily been shared among households. At the same time, specialized storage facilities can also be used to limit the access of other people, especially when they are placed in private as opposed to more public spaces, as was the case for the pedestals in Feature 1918 at the Lower Santan Platform Mound. Features such as the granaries also allow the storage of processed or partially processed foods such as shelled corn kernels, which substantially reduces their volume and, therefore, allows for greater caloric return per unit volume. Granaries also allow more secure storage of grains, and they are designed to prevent animals or insects from accessing the food. These and other beneficial factors appear to have contributed to the decision of the Lower Santan residents to invest additional effort in the construction of specialized storage structures.

Some form of food storage is essential for all societies, but individual and group needs and methods varied (Cashdan 1990; Fish 2004; Halstead and O'Shea 1989). Considerations for the prehistoric and historic residents of the middle Gila River included: a buffer against scarcity, seasonal storage, seed banks, feasting activities, social relationships, alternate subsistence activities, and supporting specialists. Food, especially seeds, may be stored over short periods of time for consumption or planting during specific times of the year. Also, stored resources allow feasting events to be held, which is important for maintaining relationships with other social segments. Stored foods can be traded both within and

Table 1. Previously Documented Granary Features

Location/Name	Site Number(s)	Count	Setting	Morphology	Citation
Tonto Basin					
Cline Mesa	U:3:128; U:4:007; U:4:008; U:4:009; U:4:010; U:4:029; U:4:077	21	Intramural	Low, circular adobe and stone platform	Oliver and Jacobs 1997
Cline Mesa	U:3:140	1	Extramural	Low, circular adobe and stone platform	Oliver and Jacobs 1997
Cline Mound	U:4:033	9	Extramural	Low, circular adobe and stone platform	Rice et al. 2009
Rock Island	U:8:023	6	Intramural	Low, circular adobe and stone platform	Lindauer 1995
Rock Island	U:8:023	3	Extramural	Low, circular adobe and stone platform	Lindauer 1995
Livingston	V:5:066; V:5:128	8	Intramural	Low, circular adobe and stone platform	Jacobs 1994
Livingston	V:5:112; V:5:121	3	Extramural	Low, circular adobe and stone platform	Jacobs 1994
Schoolhouse Mesa	U:8:454	2	Intramural	Low, circular adobe and stone platform	Lindauer 1996, 1997
Schoolhouse Mound	U:8:024	3	Extramural	Low, circular adobe and stone platform	Lindauer 1996, 1997
Schoolhouse Mound	U:8:024	43	Intramural	Low, circular adobe and stone platform	Lindauer 1996, 1997
Uplands	U:3:198; U:8:530	3	Intramural	Low, circular adobe and stone platform	Oliver 1997
VIV Ruin	N/A	1	Intramural	Low, circular platform with remnants of basketry	Mills and Mills 1975
San Pedro River Valley					
Babocomari	AZ EE:7:1(ASM)	3	Extramural	Adobe and stone?	Di Peso 1951
Camp Village	AZ BB:6:5 (ASM)	2 or 3	Extramural	Low, circular adobe and basketry platform with partially intact walls	Clark and Lyons 2012
Tres Alamos	AZ BB:15:1(ASM)	7	Extramural	Low circular base, puddled adobe	Di Peso 1951; Tuthill 1947
Phoenix Basin					
Casa Grande Ruins National Monument	AZ AA:2:5(ASM)	1	Intramural	Round, flat-topped adobe only pedestal; Described as "modified pot rest"	Fewkes 1913; Spears 1973:17
Vahki Village	AZ AA:2:66(ASM)	1	Intramural	Low, slightly concave platform	Darling 2009
Miami-Globe Highlands					
Canyon Creek Ruin/ Fort Apache Reservation	AZ C:2:8 (GP)	1	Intramural	Adobe coated basketry	Haury 1934
Carlota Copper Mine	AZ U:12:58 (ASM); AZ V:9:262 (ASM)	2	Intramural	Low, circular adobe and stone platform	Fox 2002; Yoder and Zyniecki 2002
Payson Region					
Goat Camp	AR-03-12-04-968	1	Intramural	Low, half-round adobe and stone platform, abutting wall; two layers of stone slabs	Wood 2017
Rye Creek Ruin	NA9684	2	Intramural	Low, circular platform with remnants of basketry	Haury 1935; Elson and Craig 1992
Other Locations					
Amerind (Texas Canyon, AZ)	N/A	8	?	Low, circular stone platform (no adobe?)	Fulton 1934
Paquimé (Chihuahua, Mexico)	Multiple	Not available	Rock shelter	Large to very large circular "olla" shaped structures; adobe over long coils of grass	Kidder 1936; Lumholtz 1902; Sayles 1936; Sanchez 1986
Swartz Ruin (Mimbres River, NM)	N/A	4	Extramural	Low, circular adobe and stone platform	Cosgroce and Cosgrove 1932

Figure 11. Intramural granary pedestals within Feature 2 at V:5:128/1011, Tonto Basin, Arizona. Photograph courtesy of Arleyn Simon (Arizona State University).

outside of communities. Maintaining surplus storage also allows the pursuit of alternative subsistence strategies; for example, individuals could spend more time cultivating agave or large game hunting, with stored food bridging the gaps in productivity of these techniques. In some instances surplus foods were stored for use to support fulltime non-subsistence specialists such as craftsmen. However, while there is evidence for part-time specialization, there is little evidence of fulltime specialists along the middle Gila prior to the arrival of Euro-Americans (Abbott 2009; Bayman 2002; Haury 1976; Russell 1908).

While the Lower Santan granaries are comparatively large, the total storage volume of the features appears to be insufficient to support an entire platform mound community, including all of the associated residential compounds. Although only the bases of the features were preserved, data for historical examples can be employed to estimate the capacities of the granaries in Feature 1918. Akimel O'Odham storage baskets averaged between 0.5 meters tall to 1.5 meters tall, and the ratio of maximum height to maximum width ranged from 1:1 to 1:1.5, with an average ratio of 1:1.26. As a comparison, Lindauer (1996:847) determined an average height of 0.70 meters for the smaller granaries in the Tonto Basin. The Santan pedestals are all similar in size, averaging 1.85 m in diameter. If we assume the area within the granaries is cylinder shaped, we can use the known radius of the granaries (0.925 meters) and the calculated height ratios in order to estimate storage volume of the features. Because the features were constricted at the top, this method will produce a maximum estimate that must slightly exceed the actual capacity. This results in an estimated volume of between 2.69 and 4.03 cubic meters, with a mean volume of 3.39 cubic meters for each granary.

Given the pollen and macrobotanical evidence, it is assumed that shelled dry corn was the primary material stored in the granaries. Corn has one of the highest energy densities of the foodstuffs that may have been stored within the granaries, and it therefore also represents the maximum amount of resources that could be stored in the granaries within Feature 1918. To be clear, the following estimates do not attempt to incorporate the many other stored foods that must have been present at Lower Santan village, and they exclusively pertain to the maximum amount of what could actually be held within the storage facilities that are represented by the pedestals.

Based upon the estimated volumes, each of the granaries would contain between 76 and 114 bushels of shelled and dried corn. Each bushel consists of approximately 56 pounds of shelled corn. Albino et al. (2012) state that each pound of corn provides 1,550 kCal (i.e., calorie) and Wetterstrom (1986) suggests a similar value of 1,632 kCal per pound. At the low end of this estimate, this represents about 6.60 million kCal, or 3,221 days of food for a single individual on a diet of 2,048 kCal of

Table 2. Volume, grain weight, and calorie estimates for the granaries at GR-522.

Granaries	Bushels	Pounds	kCal	Days of food (2,048 kCal)	People/yr (2,048 kCal)	Days of food (1,024 kCal)	People/yr (1,024 kCal)	People/yr w/ 2nd (1,024 kCal)
1	76	4,256	6,596,800	3,221	9	6,442	35	47
1	114	6,384	9,895,200	4,832	13	9,663	53	70
3	228	12,768	19,790,400	9,663	26	19,327	106	141
3	342	19,152	29,685,600	14,495	40	28,990	159	211
5	380	21,280	32,984,000	16,105	44	32,211	176	235
5	570	31,920	49,476,000	24,158	66	48,316	265	352

corn per day (Wetterstrom 1986:163). The upper end of the estimate represents 9.90 million kCal, or potentially enough corn to sustain an individual for 4,832 days. If we assume an additional two granaries are present in the unexcavated portion of the room, the maximum total storage for the five granaries is estimated to be between 380 and 570 bushels (Table 2). Assuming a diet of 2,048 kCal of corn per day and the maximum volume for five granaries (including the two hypothetical ones) full of shelled dry corn, this would provide sufficient food for a community of only 66 people, which is substantially smaller than the estimate of 166 people for the mound precinct alone (Woodson 2010, 2016). However, in most cases, corn was unlikely to provide the entirety of an individual's calories, with most estimates being about half of total calories (Altschul and Van West 1992; Wetterstrom 1986), but it could perhaps be as low as 25 percent under atypical conditions (Castetter and Bell

Figure 12. Extramural granary pedestals within a plaza (Feature 7) at AZ V:5:121/999, Tonto Basin, Arizona. Photograph courtesy of Arleyn Simon (Arizona State University).

1942; Hunt and Ingram 2014; Rea 1997). If we use the most common estimate and divide the consumption by half (i.e., 1,024 kCal of corn per day), then the maximum volume for 5 granaries may have been sufficient to satisfy the requirements of people living within the platform mound precinct, but this still would have been insufficient for all of the settlements along the Santan canal in the vicinity of the mound. It is also possible that two crops of corn were raised each year, but these two harvests would occur several months apart from each other, and the granaries would still be largely full at the time of the second harvest (Hunt and Ingram 2014). Consequently, this possibility would only slightly extend the length of time an entire platform mound community could be supported on food from only the granaries in question. Thus, even if two additional unidentified granaries were present in Feature 1918 and assuming two crops were grown each year, the storage volume is insufficient to supply the yearly needs of all people who must have been living along the Santan canal. Consequently, it is unlikely that the features are a form of communal storage facility where all goods were held until being redistributed back to the residents.

While it is clear the storage provided by the pedestals would have been insufficient to maintain a platform mound community including the associated residential settlements for a substantial length of time, the features are at the upper end of the previously identified examples. Even using the more conservative estimates, the total storage volume still substantially exceeds the needs of an individual household. Furthermore, the largest pedestal examples from the Tonto Basin all occurred in extramural locations, which implies communal access existed for these larger examples. In contrast, the granary features at GR-522 were located within a room, which suggests that access to these resources was more restricted. The Feature 1918 pedestals were also located within the platform mound compound, where higher status individuals are generally thought to have resided (Bayman 2002; Brunson 1989; Crown and Fish 1996; Elson 1998; Lindauer and Blitz 1997; Mitchell 1994; Mitchell and Brunson-Hadley 2001). These factors suggest that the features represent specialized storage, probably for one or more households that had extensive social obligations, such as hosting large ceremonies that included community-scale feasts (Cameron 1995; Grimstead and Bayham 2010; Mills 2007; Potter 2000).

The pedestals that were identified at Lower Santan village were located in a secluded setting behind the walls of an unusually large adobe structure. Therefore, they would not have been visible to most visitors. This context is an unlikely location for displaying intentional symbols of cultural affinity, and it is improbable that the granaries were constructed for this purpose (Carr 1995). Instead, it is probable that the rock and adobe granary bases from Lower Santan represent an idea that was copied from people living outside the immediate area,

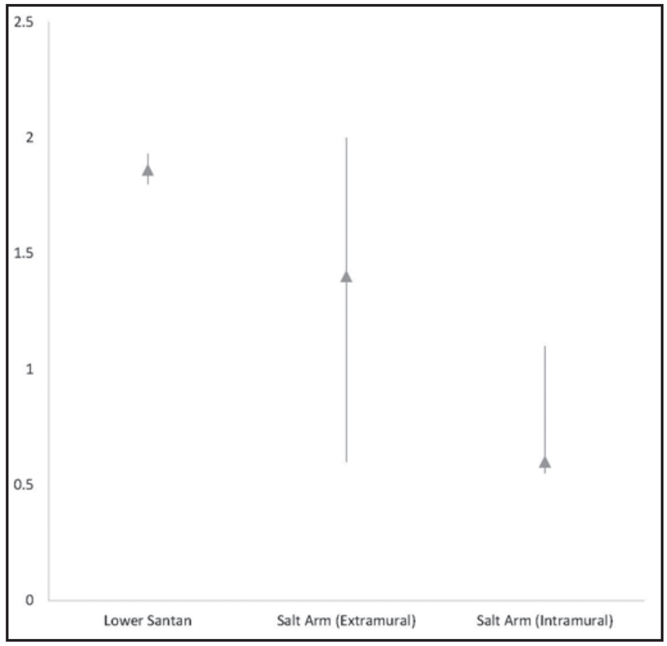

Figure 13. Maximum, minimum, and mean pedestal diameters in meters for Lower Santan Mound and the Livingston area along the Salt arm of the Tonto Basin (adapted from Jacobs 1994).

or these storage features may have been introduced by immigrants who moved to the middle Gila River area from elsewhere. Given that granaries are most common in the Tonto Basin and the San Pedro Valley, those areas represent a possible origin for such people or ideas.

Historical and archaeological evidence shows the O'Odham populations from elsewhere in southern Arizona, including the San Pedro River, immigrated to the middle Gila during the Historic period (Loendorf 2012, 2014; Wilson 2014). Although the features at Lower Santan substantially predate the population movements that were documented in the 1700s and thereafter, the observation that people are known to have relocated from regions such as the San Pedro establishes the possibility that the Lower Santan pedestals were influenced or built by immigrants in prehispanic times.

CONCLUSIONS

Granary pedestals are distinctive rock and adobe grain storage facilities that were made during the Classic period in the southern Southwest. The distribution of these features occurs in an arch along the northern and eastern margins of the Hohokam region, from just below the Mogollon rim in south central Arizona extending south into Mexico. Pedestals are found within room, plaza, or courtyard areas, and they always occur within walled compounds. Although these features may not have always been recognized, granary pedestals appear to have only rarely (if ever) previously been found within the Hohokam heartland in the Phoenix Basin.

The three rock and adobe pedestals found in Feature 1918 at the Lower Santan Platform Mound appear to be similar to examples that have previously largely been found in the hinterlands surrounding the Hohokam core area. Estimation of the storage volumes for the Feature 1918 granaries suggests that they would have held an insufficient supply of food for all settlements within a platform mound community for an entire year. As a result, the features do not appear to be part of a communal storage facility where all goods were held for redistribution. Nevertheless, the volumes of the features are at the upper end of the previously identified examples, and the total storage potential dramatically exceeds the needs of an individual household as well as the residents of the platform mound compound. The granaries were also located within a context where higher status individuals are thought to have lived at the platform mound. These observations suggest that the pedestals were used to store foodstuffs for special events such as intra- or inter-community feasts.

The pedestals were also constructed in an area with restricted access, and the features are not of a variety that is likely to have been emulated for purely social purposes. Instead it is more likely that the construction techniques of the Lower Santan granaries were introduced from elsewhere, possibly by diffusion of ideas or immigration from hinterland areas like the Tonto Basin or the San Pedro River portions of the Hohokam region of southern Arizona. Further research is necessary to determine if additional evidence for immigrants is present elsewhere within the Lower Santan Classic period community.

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STONE SPHERES AND CUBES IN THE SOUTHWESTERN PAPAGUERÍA

Richard Martynec
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ABSTRACT

Stone spheres, or balls, are understood to have been and continue to be employed in games, prolonged runs, weapons and possibly for other purposes (Adams 2014; Castetter and Underhill 1935; Ezell 1954; Fontana 1989). These objects are not rare in the Southwest, but neither are they common. Stone cubes, on the other hand, are rare. Examination of a set of 244 stone spheres and four cubes in the southwestern Papaguería reveals morphologically variable, but dimensionally similar assemblages of these artifacts, principally between 4 and 8 centimeters (cm) in size; more than half are fractured. While an assortment of materials was selected to fashion the spheres, quartzite and basalt were preferred. Most, if not all, were utilized during the Ceramic period and, conceivably, were produced locally. Two spheres were found between the Growler Mountains and the Tohono Indian Reservation whereas 241 were located between the Growler and Cabeza Prieta Mountains.

INTRODUCTION

Stone spheres are not common at archaeological sites in the U.S. Southwest. As will be demonstrated in the following narrative, however, these objects are far more abundant in specific areas in the southwestern Papaguería. This investigation defines two such areas, examines the physical settings where these unique artifacts were found and questions who may have been responsible for their distribution based on the locations where they were discovered.

Ethnographic studies suggest that stone spheres were used as gaming pieces, racing stones, club heads, or objects used to create noise (Adams 2014). Stanley Cruz (personal communication, 2018), the Chairman of the Pisinimo District of the Tohono O'odham Nation, and Bernard Fontana (1989) report that balls are, and have, been used by the O'odham with their feet, ankles, knees and thighs (no hands) during long distance runs. Ezell (1954:8) states that balls were "probably used in the aboriginal version of the Papago-Pima foot-race." And, Castetter and Underhill (1935) observed "athletic contests in which the youths of the different villages contended at kick ball and relay racing were yearly events, and a fast runner, famous in racing, was as highly esteemed as any warrior."

The material selected for the ball was game- or task-specific and was decided by a medicine person, possibly foretold in a dream. Stone balls of different materials are still manufactured according to Angela Garcia-Lewis (personal communication, 2016), the Cultural Preservation Compliance Supervisor for the Salt River Pima-Maricopa Indian Community.

Adams (2014) defines stone spheres, or balls, as any roughly spherical piece of stone and acknowledges that it may be difficult to determine if an object is naturally spherical or created by grinding to shape. Stone spheres have been found in the Tucson Basin in Late Archaic (800 B.C.–A.D. 150) and Early Ceramic (A.D. 150–550) contexts, throughout the U.S. Southwest during later Ceramic times (A.D. 700-1500) and continue to be used today by the O'odham.

While research into ancestral ball game activities in the U.S. Southwest has primarily focused on the public architecture of the game, including ball courts and racetracks, Hart (2018) concentrated on another aspect of the ball game: the ball itself. There is ethnographic evidence that the O'odham coated these stone balls with resins and gums. Emil Haury posited that this practice could have occurred prior to contact with Europeans. With this in mind, stone balls in the Casa Grande Ruins National Monument collections were analyzed under ultraviolet light (UV) for luminescence and fluorescence to investigate for residues unseen in normal illumination (Hart 2018). Colors revealed under the UV light in-

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dicate the presence of resin, gum or clay residues on these Hohokam artifacts, thus supporting the view of pre-contact use of kickballs.

Historian Harry Winters Jr. (personal communication, 2018) explains that the kickball race is called wuichuda, and the ball is shongiwul. The race features in the Ho'ok story told to him by Barnaby Lewis, and noted by Bernard Fontana (1989), of a young man, of whom 'I'itoi was jealous, who was practicing for this race. 'I'itoi had instructed a girl to sit along the path that the man would follow when he practiced and to grab his shongiwul and sit on it to hide it. She was to refuse to return the ball to him and tease him into drinking a potion 'I'itoi had given her. She did as instructed. The potion caused the man to turn into a giant eagle. When the girl looked for the ball she sat on, she couldn't find it. It had disappeared inside her and she became pregnant. When the baby was born, it was the child who became Ho'ok, which leads to another story.

Joe Joaquin, a Tohono O'odham elder and former Cultural Affairs Specialist, recounts a story told to him by his grandfather. Sometime in the 1870s several O'odham men, including the grandfather, arranged a stone ball game with Mexicans just south of the border, below what is today Papago Farms. The bet was all of their cattle! The O'odham prevailed and were moving the Mexican's cattle north when the Mexicans decided to try to stop them. Fortunately, a medicine man was traveling with the O'odham, and he created a spell that caused the wind to blow exceptionally hard obscuring the Indians trail. So, the Indians made it home with the cattle.

THE UNIVERSE

Several archaeological surveys have been completed west of the eastern boundary of the Tohono O'odham Reservation, east of the Cabeza Prieta Mountains, south of the southern boundary of the Barry M. Goldwater Range and north of a line approximately 30 km south of the International Border (Figure 1). These projects were sponsored by and undertaken on land managed by Cabeza Prieta National Wildlife Refuge, El Pinacate Biosphere, and the Bureau of Land Management in attempts to better understand the prehistory of the poorly understood areas west of and surrounding Ajo, Arizona. All were conducted utilizing similarly controlled, systematic, non-collection surveys and recording methods (with three exceptions) thus yielding comparable data. The three exceptions are Cabeza Prieta Tank, Dos Playas and Heart Tank, all of which were revisited due to limited and dated documentation and to acquire specific information, including the presence of stone spheres. Table 1 identifies the projects considered in this study, acreage surveyed, number of spheres, and physical setting.

THE SPHERES AND CUBES

Daniels Valley

A quartzite sphere measuring 5.5 cm in diameter at Site 828 and a 3.2×3.4 cm granite specimen at Site 850 (Figure 2) were the only ones identified during this survey in the valley adjacent to the eastern flanks of the Growler Mountains. Both artifacts have been pecked and ground into nearly flawless spheres. Tanque Verde Red-on-brown and Sells Red sherds were noted at the former, and at the latter are Archaic and Ceramic period artifacts.

Site 850 is on an undulating sand flat at the headwaters of the Daniels Arroyo, whereas Site 828 is on the middle bajada of the Growler Mountains on uneven sand, gravel and rocks where two large washes converge. Trails dissect the landscape at both sites.

Charlie Bell Canyon

A sphere at Charlie Bell Hohokam Village (AZ Y:12:4 [ASM]) was the only one discovered during the survey of the canyon. This carefully crafted basalt artifact is spherical with the exceptions of the opposing poles, both of which have been ground flat. This artifact measures 6 cm around the circumference. The authors could not find any diagnostic artifacts when this site was recorded in 1995; however, Ezell (1952) and Fontana (1965) mention the presence of Hohokam red-on-buff pottery at this site. It may be noteworthy that east-west oriented trails bisect this site, and some of the petroglyphs are heavily patinated suggesting an Archaic presence as well.

Playa Diaz

A nearly perfect quartzite sphere measuring 6×6.5 cm was recorded along the perimeter of this playa at the northeast corner of Sierra Pinacate in Sonora, Mexico. Trincheras and Lower Colorado Buff Ware sherds, trails, and patinated basalt chipped stone artifacts are nearby.

Los Vidrios

A well-shaped quartzite sphere measuring 6.7 cm in diameter is at Site 530 in the sand flats on the south side of Rio Sonoita. Plain ware sherds accompany this artifact; no features were noted.

Pinta Playa

There are four quartzite stone spheres at three sites on the sandy flats along the south and east sides of this playa, which borders the Pinta Sands. The playa is at the northern tip of the Pinacate Lava, 7 km north of the International Border. Lower Colorado Buff Ware sherds are present at all three sites, and trails crisscross the area in and around the playa. Two of the artifacts are roughly circular in shape with limited smoothing and diameters of 3-3.5 cm. The dimensions of the other two were not acquired.

Growler Valley

This is an on-going project. However, the data base, which totals 100 spheres (including those at Lost City and Southwest of Charlie Bell Canyon) (Table 2) and two cubes, is considerable and therefore included in this study. The well-formed quartzite cube recorded as Isolate 145 is a 4.7×4 cm rectangle on one side and a 4.8 cm diameter sphere on the opposite side. The imperfect basalt specimen at Site 641 measures 6.5×6×6 cm.

The Growler Valley sites with spheres are primarily on sandy, creosote flats on the lowest bajada of the Growler Wash. Lost City and Playa Concha (Site 655), which are within 2 km of the wash, are possible villages containing thousands of artifacts and features, extensive evidence of shell jewelry production and resource reduction, and it has been reported (Schnell personal communication, 2005) that a seep was still active at Lost City into the 1920s.

One basalt (Figure 3) and three quartzite well-formed spheres were recorded in 2003 at Lost City; one of the quartzite balls is a fragment and another is lightly battered. Three additional spheres collected from Lost City in 1952 are curated at the Western Archeological and Conservation Center in Tucson according to Organ Pipe Cactus National Monument Archaeologist Laura Kingston (personal communication, 2018). One is quartzite, one is basalt, and the other is granite.

Eleven complete stone spheres at seven sites (Sites 801, 803, 804, 805, 809, 825 and 827) and two isolates were found during the course of the Southwest of Charlie Bell Canyon project. The artifact at Site 825 is well-shaped and smoothed while the others are rougher, less well-shaped, and display varying degrees of battering. The physical setting of the project area is within the transition zone between the middle to lower bajadas of

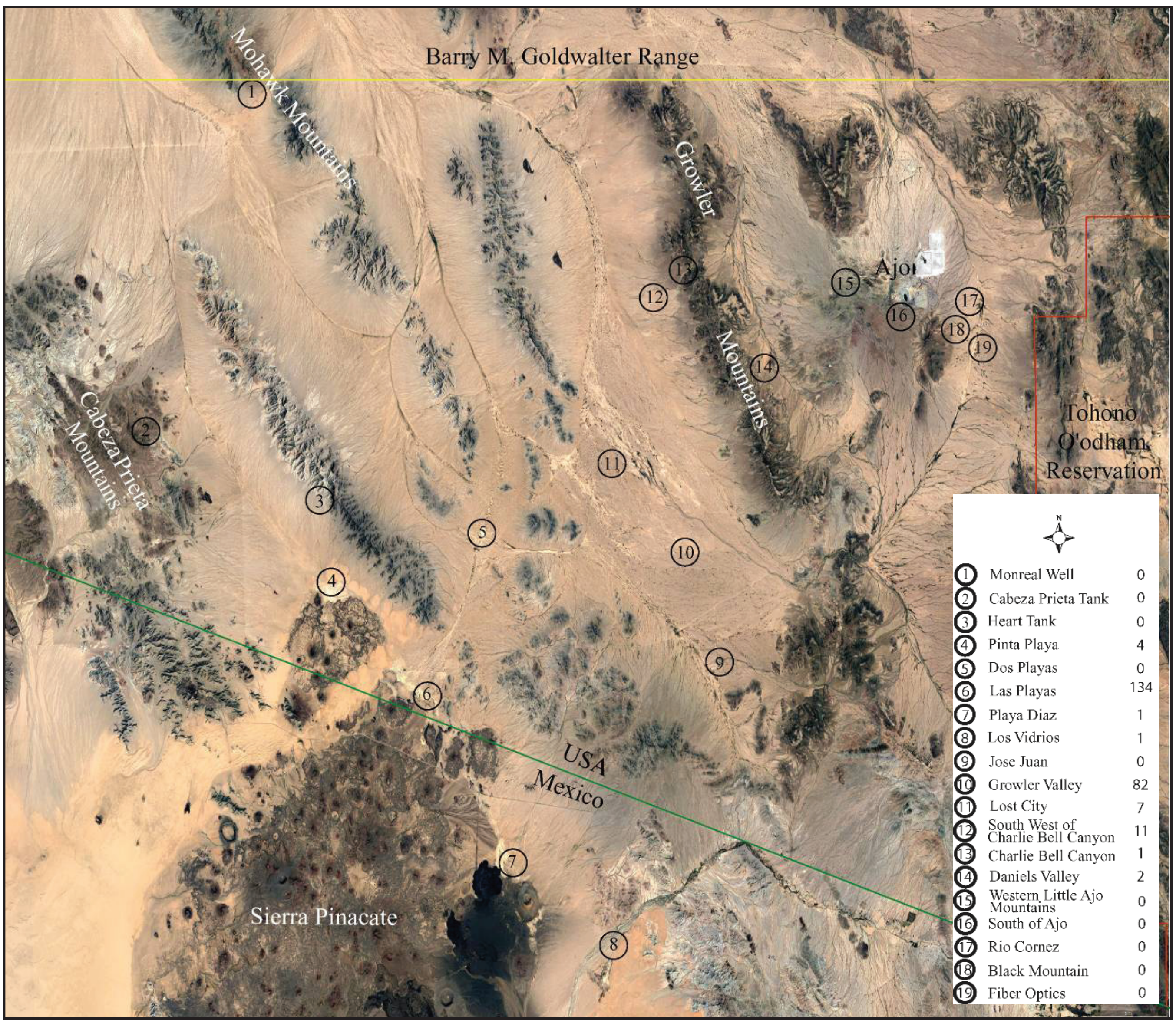

Figure 1. Location of Projects and Number of Spheres

Table 1. Project, Acreage, Number of Spheres, Geomorphic Settings and Reference

Project	Acreage	Number of Spheres	Geomorphic Setting	Reference
Fiber Optics	25.5	None	Valley floor to lower bajada	Goldstein 2005
Las Playas	16,000	135	Playa and adjacent dunes	Martynec and Martynec 2011; 2014c
Black Mountain	1,860	None	Valley floor to upper bajada	Martynec and Thompson 2005; Martynec et al. 2011; 2019
South of Ajo Mine	2,918	None	Middle to upper bajada and canyons	Hooper 2012
Rio Cornez	1,360	None	First terrace of a secondary wash	Martynec and Martynec 2015
Daniels Valley	10,200	2	Valley floor to middle bajada	Martynec and Martynec 2019
Charlie Bell Canyon	500	1	Canyon bottom	Martynec and Martynec 2016a
Growler Valley *	12,609	100	Valley floor and lower bajada	Martynec and Martynec 2006; 2014a; 2014b
Monreal Well**	371	None	Valley floor	
Los Vidrios	210	1	Sandy flats and hillsides along the Rio Sonoyta	Martynec et al. 2011
Playa Diaz**	30	1	Playa	
Pinta Playa**	1137	4	Playa	
Western Little Ajo Mountains**	2,000	None	Middle to upper bajada and canyons	
Heart Tank**		None	Canyon and sandy flat west of Sierra Pinta	
Cabeza Prieta Tank		None	Canyon and sandy flat west in Cabeza Prieta Mountains	Martynec and Martynec 2016b
Dos Playas**		None	Playa	

* Includes Lost City, Southwest of Charlie Bell Canyon and Jose Juan Temporal Projects
**These projects are in progress and no reports are available at this time.

the Growler Mountains, 7 km east of the Growler Wash; the elevation decreases less than 50 m over the 7 km span. The sites are located primarily on sandy flats partially covered with small rocks and gravel.

Las Playas

Altogether, 135 stone spheres (Table 3) and two cubes were recorded at Las Playas; all are either adjacent to the playas or in the dunes bordering them. The

Figure 2. Granite Sphere at Daniels Valley Site 850

Figure 3. Basalt Sphere at Lost City AZ Y:16:1 (ASM)

Table 2. Stone Spheres in the Growler Valley

Site	Material	Count	Condition	Size (cm)	Associated diagnostic artifacts
Lost City	Quartzite	4	3 W, 1 P	7	Patayan, Trincheras, Santa Cruz Red-on-buff, Sacaton Red-on-buff, Salado Polychrome, Tanque Verde Red-on-brown, red ware
	Basalt	2	2 W	6	
	Granite	1	W		
801	Quartzite	1	W	6.5	Patayan, Tanque Verde Red-on-brown, Salt Red, Hohokam buff, Anasazi
803	Basalt	2	2 W	6.5	Patayan, Tanque Verde Red-on-brown, Sacaton Red-on-buff, Papago, Anasazi, Hohokam buff, red ware
804	Unknown	1	W		Patayan, Salado Polychrome, Tanque Verde Red-on-brown, Anasazi, red ware
805	Basalt	2	W	6.5	Patayan, Sacaton Red-on-buff
809	Basalt	1	W	7	Patayan
825	Quartzite	1	W	5.5	Patayan, Sells Red, Papago Red-on-brown
827	Granite	1	W	7.5	Patayan, Tanque Verde Red-on-brown, Salt Red, Anasazi, Hohokam buff
IO 101*	Quartzite	1	W		
IO 147*	Basalt	1	W	5.5	
502	Basalt	1	W	5.5	Trincheras, Gila Butte Red-on-buff
	Quartzite	8	7 P	5.5	
507	Basalt	1	W	7.4	Trincheras
	Quartzite	2	2 W	7	
536	Quartzite	1	P		
541	Basalt	1	W	6.5	Ceramics
542	Quartzite	1	P	6.5	Patayan
566	Quartzite	4	2 W, 2 P	5.3	Archaic, Trincheras, Hohokam, Patayan
576	Basalt	2	2 P	6.8	Santa Cruz Red-on-buff, Trincheras, Patayan
	Quartzite	4	4 W	5.5	
	Granodio-rite	1	P	9	
578	Quartzite	1	P	5.3	Ceramics
581	Granite	1	W	7.6	Ceramics
	Quartzite	2	2 W	6.5	
591	Quartzite	2	2 P	7.5	Trincheras
596	Quartzite	1	P	8	Ceramics
602	Quartzite	1	P		
603	Quartzite	2	2 P	5.5	Trincheras
605	Quartzite	1	P		Ceramics
	Basalt	1	W	7.5	
607	Quartzite	3	3 P	6.2	Trincheras
609	Quartzite	3	1 W, 2 P	4.8	Red ware
611	Quartzite	1	P		Trincheras
612	Quartzite	1	P		Trincheras
615	Basalt	1	W	7.8	Trincheras
	Quartzite	2	2 P	8.3	
619	Quartzite	1	P		Ceramics
620	Quartzite	2	1 W, 1 P	5.7	Patayan

W - Whole
P - Partial

Table 2. Stone Spheres in the Growler Valley (continued)

Site	Material	Count	Condition	Size (cm)	Associated diagnostic artifacts
621	Basalt	1	P	7	
	Quartzite	1	P	6	
624	Quartzite	2	2 P		Trincheras
631	Quartzite	1	P		Trincheras
634	Quartzite	1	P	5	Ceramics
641	Basalt	1	W	6.3	Trincheras
642	Quartzite	4	1 W, 3 P	6.2	Trincheras, Gila Butte Red-on-buff and Patayan
	Basalt	2	1 W, 1 P	8.5	
	Sand-stone	1	W	6.3	
655	Tuff	1	W	5.5	Casa Grande Red-on-buff, Trincheras, Patayan and Salado Polychrome
	Unknown	1	W	7.5	
	Basalt	1	W	11.7	
	Milky quartz	1	W	4.8	
IO 9	Unknown	1			
IO 113	Quartzite	1	W	5.8	
IO 122	Quartzite	1	P		
IO 145	Quartzite	1	W	5.3	
IO 178	Quartzite	1	W	9.8	
IO 236	Quartzite	1	W	10	
IO 254	Basalt	1	W	5.5	
IO 279	Quartzite	1	P		
IO 329	Quartzite	1	P	5.2	
IO 344	Quartzite	1	P	3	
IO 346	Quartzite	1	P	6	
IO 358	Quartzite	1	W	7.3	

* Isolates from the Southwest of Charlie Bell Canyon Project

W - Whole
P - Partial

imperfect basalt cube at Site 552 measures 5.8×7.5×5.8 cm and the perfect granodiorite cube at Site 593 is 5.7×6×5.5 cm (Figure 4). The cube at Site 593 is a completed artifact, not an unfinished sphere.

Figure 4. Granodiorite Cube at Las Playas Site 593

SUMMARY

The sizes of the stone spheres are similar (Table 4) with 68.6 percent averaging between 4.5 and 7.0 cm, 17.6 percent are larger than 7.0 cm, and 13.7 percent are smaller than 4.5 cm. Expanding the parameters to include stone spheres in the 4-8 cm size range yields a total of 88.9 percent of the artifacts. The smallest measures 2.75 cm, and the largest is 11.7 cm.

Table 3. Stone Spheres at Las Playas

Site	Material	Count	Condition	Size (cm)	Associated diagnostic artifacts
9.5	Quartzite	1	P	6	Ceramics
501	Milky quartz	1	P	5.5	Archaic
503	Quartzite	1	P	6.5	Sacaton Red-on-buff, Trincheras, Patayan
506	Quartzite	1	P	5	Ceramics
507.2	Quartzite	1	W	3.8	Trincheras
507.3	Quartzite	1	W		Sacaton Red-on-buff, Patayan
507.5	Quartzite	1	P		Patayan
	Basalt	1	P		
507.7	Quartzite	1	P		Sacaton Red-on-buff, Patayan
507.8	Quartzite	2	1 W, 1 P	5.5	Patayan
507.13	Quartzite	1	W	5	Patayan
	Basalt	1	W	4	
507.16	Quartzite	3	1 W, 2 P	4.8	Sacaton Red-on-buff, Tanque Verde Red-on-brown, Salado Polychrome, Patayan
507.18	Granite	1	P		Patayan, Salado Polychrome
	Quartzite	1	P		
	Basalt	1	P		
507.19	Quartzite	1	P		Ceramics
507.2	Granodiorite	1	P		Sacaton Red-on-buff, Trincheras, Patayan
508	Quartzite	1	W	5	Archaic, Sacaton Red-on-buff, Salt Red, Trincheras, Patayan
510	Quartzite	1	W		
513	Quartzite	1	P	5.5	Hohokam, Patayan, Trincheras, Papago
515	Quartzite	1	P	4	Archaic, Sacaton Red-on-buff, Trincheras, Patayan
516	Milky quartz	1	P	5	Patayan
526	Quartzite	1	P		Patayan
528	Quartzite	2	2 W	6	Hohokam, Patayan
528.1	Quartzite	5	3 W, 2 P	6	Sacaton buff, Tanque Verde Red-on-brown, Trincheras, Patayan
528.2	Quartzite	1	W	5	Middle Archaic, Patayan, Trincheras
529	Basalt	1	W	5.3	Archaic, Patayan, Trincheras
	Quartzite	1	P	6	
531	Quartzite	6	1 W, 4 P	5.9	Archaic, Patayan, Hohokam red-on-buff, Papago
	Granite	1	P		
	Basalt	1	W	5.5	
531.1	Quartzite	5	5 W	3.8	Patayan, Hohokam red-on-buff, Papago
531.2	Quartzite	1	W	3.5	Patayan
531.3	Quartzite	1	P	3.5	Ceramics
531.10	Basalt	2	1 W, 1 P	6	Patayan
	Milky quartz	1	P		
533	Quartzite	3	2 W, 1 P	6	Patayan, Santa Cruz-Sacaton Red-on-buff
	Basalt	1			

W - Whole
P - Partial

Table 3. Stone Spheres at Las Playas (continued)

Site	Material	Count	Condition	Size (cm)	Associated diagnostic artifacts
534	Quartzite	8	2 W, 4 P	5.8	Patayan, Sacaton Red-on-buff, Trincheras
	Basalt	2	1 W, 1 P	4.5	
	Tuff	1	P		
	Granodiorite	1	W		
534.2	Granodiorite	1	W		
	Basalt	1	P		
534.3	Quartzite	1	W		Patayan
534.4	Quartzite	2	2 P	6	Middle Archaic, Patayan, Sacaton Red-on-buff
	Granodiorite	1	P	6	
	Basalt	1	P		
534.6	Basalt	1	W	4.5	Archaic, Patayan, Sacaton Red-on-buff
534.7	Quartzite	4	4 P		Early-Late Archaic, Patayan
	Tuff	1			
540	Quartzite	2	1 W, 1 P	6.3	Archaic, ceramics
549	Milky quartz	1	P	7	
552	Quartzite	4	1 W, 2 P	5	Early-Late Archaic, Patayan, Trincheras, Santa Cruz Red-on-buff
	Granodiorite	1	W	5	
555	Quartzite	2	2 P		Late Archaic, Hohokam, Patayan, Trincheras
567	Quartzite	1			Santa Cruz-Sacaton Red-on-buff, Patayan
571	Quartzite	1	P	6.5	Patayan
572.2	Quartzite	2	1 W, 1 P	4.3	Patayan
572.3	Quartzite	1	W	4.9	Patayan
573	Basalt	1	W	5	Ceramics
575	Quartzite	1	W	4	Early-Late Archaic, Patayan, Sacaton Red-on-buff
581	Quartzite	1	P	4	
582	Quartzite	1	P		Patayan
583	Quartzite	1	W	6.5	Late Archaic, ceramics
589	Quartzite	1	P	6	Early-Late Archaic, Patayan, Hohokam
593	Basalt	1	W	7.5	Hohokam
595	Quartzite	1	P	5	Patayan, Hohokam
597	Quartzite	1	P		Santa Cruz-Sacaton Red-on-buff
599	Quartzite	3	3 P	6.3	Middle Archaic, Patayan
612	Basalt	1	P		Patayan
627	Quartzite	1	W	8	Early-Late Archaic, ceramics
628	Quartzite	1	P		
638	Quartzite	1	P		Hohokam
649	Basalt	2	2 W	7.3	Patayan, Hohokam, Papago
IO 3	Quartzite	1	P		
IO 51	Quartzite	1	P		
IO 52	Quartzite	1	P		
IO 54	Quartzite	1			

W - Whole
P - Partial

Table 3. Stone Spheres at Las Playas (continued)

Site	Material	Count	Condition	Size (cm)	Associated diagnostic artifacts
IO 55	Quartzite	1	P		
IO 118	Quartzite	1	P		Ceramics
IO 156	Quartzite	1	P		
IO 222	Quartzite	1	W	6	
IO 230	Sandstone	1			
IO 232	Quartzite	1	P	6	
IO 248	Quartzite	1	W		
IO 252	Quartzite	1	P		
IO 395	Quartzite	1	W	5.2	
IO 463	Basalt	1			
IO 595	Basalt	1	W	8	
IO 614	Quartzite	1	W	7.5	
IO 692	Quartzite	1	W	6.5	
IO 693	Basalt	1	P		
W	Whole				

W - Whole
P - Partial

Quartzite was selected for 73.0 percent of the stone spheres, basalt accounts for 17.8 percent, and other materials for 9.1 percent. The other materials include granodiorite, granite, milky quartz, volcanic tuff, sandstone, and indeterminate.

As can be seen in Table 1 and was discussed in the project narratives, the areas that produced the vast majority of the stone spheres are in open, flat settings; and those where stone spheres were absent, or nearly so, are on bajadas and near canyons.

A majority of the spheres are fragments, but only by a slight margin. Whole specimens represent 44.8 percent of the assemblage; the remainder is fragments. The amount of incompleteness is considerable in some cases, with estimates of the amount of the object remaining as low as 25 percent. Since some of these artifacts are so small it is conceivable that a few are pecking stones or the tips of broken pestles or manos. But if this is so, the number is low because recorders carefully scrutinized the fragmented artifacts specifically checking for these characteristics; and if questionable, then the artifact was classified as a ball/hammerstone, ball/mano, or ball/pestle, and those objects were not considered in this study.

Four additional artifacts were pecked and ground into faceted cubes; two were discovered in the Growler Valley, and two at Las Playas. Two are basalt, one is quartzite, and one is granodiorite. Two are perfect cubes, one is irregularly cubical, and one is cubical at one end and spherical at the other.

DISCUSSION

Stone spheres, balls, and possibly cubes were and are used during games and along the routes of extended runs according to ethnographic studies and interviews.

Table 4. Summary of Stone Sphere Data

Project	Total	Whole	Quartzite	Basalt	Other material	2.5-4.3 cm	4.5-7 cm	7-11.7 cm
Las Playas	135	51	100	21	14	12	57	7
Growler Valley	100	48	69	21	7	6	44	20
Los Vidrios	1	1	1				1	
Pinta Playa	4	4	4			2		
Daniels Valley	2	2	1		1	1	1	
Charlie Bell Canyon	1	1		1			1	
Playa Diaz	1	1	1				1	
Total	244	108	176	43	22	21	105	27

The artifacts considered in this analysis are comparatively homogeneous in size but vary substantially in morphology ranging from perfect spheres to crudely shaped ones to cube-like objects (Figure 5). These results appear to match Adams (2014) observation that stone spheres, or balls, are roughly spherical pieces of stone, and that it may be difficult to determine if an object is naturally spherical, created by grinding to shape or those extensively used. Stone (1994) contends that spheres have been pecked and lack evidence of use. We concur that some spheres have been pecked to shape but we disagree that they lack evidence of use. More than half of the spheres are incomplete, mostly due to fracturing. Several explanations come to mind for this situation including damage from use, accidental breakage, fracturing during manufacture, or combinations of the above. Documented examples of possible accidental breakage are an entire sphere, but in five fragments, at Site 534 at Las Playas, another in two pieces at Site 552 at Las Playas, and yet another in two parts at Site 507 in the Growler Valley.

Quartzite, basalt, granite, granodiorite, and milky quartz are available throughout the region, so it is feasible that spheres were manufactured locally, and that some of the partial specimens are production debris. This may have occurred in a few instances for quartzite, but not many because there are only five locations where broken balls and quartzite chipping stations co-occur. Basalt and granodiorite are another matter. Evidence that these materials were chipped extensively throughout the region is profuse, especially granodiorite. Two quarries of this material are within the boundaries of the Las Playas Project, and groundstone artifacts and chipping debris of this material is seemingly ubiquitous in the area.

Almost certainly the stone spheres and cubes identified in the project areas under consideration are Ceramic period in age. Archaic period artifacts were noted at Diaz Playa, a site in the Growler Valley, and 17 sites or components of sites at Las Playas, but pottery is also present at all of these locations except for one. It should be mentioned, however, that temporally diagnostic artifacts are not at eight of the sites or components of sites so the possibility of Archaic period use of stone spheres in this region cannot be eliminated entirely. Historical or modern use of stone spheres in this region was impossible to determine.

Use may account for the high incidence of fractured spheres. Many of the objects display evidence of battering, but it could be argued that this occurred during manufacturing rather than from use. However, the battering evident on many of these objects is not from the process of pecking to shape, but rather the result of more severe damage produced by an impact. If individuals were kicking or kneeing a sphere while playing a game or during a long-distance run, and the ball impacted a stationary object of some mass, it could easily become battered or shattered. Further, stone spheres have been located in almost every conceivable type of archaeological, but not physical setting. Not only were they observed at large, basecamp-type loci, but likewise were found at small sites that represent single events. That these objects were also recorded as 32 isolated occurrences is particularly intriguing. If these artifacts were used during long distance runs it might follow that they were lost or broken along the route, perhaps in the locations where we discovered them. Some were near trails, but the sandy soil throughout much of the study area is not conducive to trail preservation.

There may be a partial connection between types of physical settings and where stone spheres were found. Most were discovered on the lowest bajadas along well-developed drainage systems, around playas, and on the dunes surrounding playas (Growler Valley, Las Playas, Pinta Playa, Playa Diaz, and Los Vidrios). These settings offer an excellent venue for kickball games or prolonged runs. Generally, spheres were not recorded at sites on the middle and upper bajadas, canyon ridges, or uneven terrain. The later includes Charlie Bell Canyon, Cabeza Prieta Tank, South of Ajo Mine, the Western Little Ajo Mountains, and much of Daniels Valley. In seeming contradiction, though, spheres were not observed on open

Figure 5. Perfect Sphere, Crudely Shaped Sphere and Cube-like Object

flats at Dos Playas, Heart Tank, Black Mountain, Rio Cornez, Monreal Well, and the flats adjacent to Daniels Arroyo in the Daniels Valley. While evidence of prehistoric activity at Dos Playas is virtually non-existent, the absence of spheres in the other project areas is not so easily explained. Additional survey around Heart Tank and Monreal Well might yield stone spheres, but that is not the case where extensive surveys were conducted at Black Mountain, Rio Cornez and along Daniels Arroyo. With this in mind, other factors must be considered for the near absence of stone spheres in some areas and the presence of so many in others.

Ceramic types prompted Ezell (1954) to postulate a separation point between the prehistoric users of Lower Colorado Buff Ware and Sonoran Brown Ware at the western edge of the Papago Indian Reservation. Julian Hayden (1967) divided the prehistoric and historic occupants of this western region, the Areneños or Sand Papagos, into a northeastern group termed Areneños and the individuals residing in Sierra Pinacate as Pinacateños.

> Furthermore, whereas the San Dieguito cultural remains are homogeneous over a very broad area of the southwestern deserts, the Amargosa immigrants to the Sierra Pinacate proper seem to have begun immediately to deviate from the general Amargosan culture pattern. This deviation through time is so evident that it seems proper to refer to the Sierra Pinacate as an "enclave" separated in its very nature from the Sonoran desert in general. The unique terrain of the Pinacate, with its rough lava flows, fissures, craters, and cinder cones, its uncertain water supply, its limited "carrying capacity" in terms of human occupancy, and the special skills required for survival in the lavas and the dunes to the west may have contributed to this development in comparative isolation within the enclave [Hayden 1967:337-338].

Based on his 1962 survey of Cabeza Prieta National Wildlife Refuge (CPNWR), Fontana stated (1965:99) "… I believe there were at least two groups of the Indians (Areneños, Sobas, Sand Papagos or Hiatit Ootam) living in the Cabeza Prieta Game Range as early as the 16th century. The westernmost group was made up of fully-nomadic gathering groups of extended families. It perhaps may be regarded as a single band." He continued (1965:100):

> "The southern boundary of their territory was the Gulf of California; the western boundary was the Colorado River (exclusive of Yuman use and occupation areas); the northern boundary was the Lower Gila River; the east boundary was on a line down the Mohawk Mountains southeast to Sonoita, Sonora, and south to the vicinity of the modern Puerto Peñasco, Sonora … The second group of these western Papagos … were bounded on the north by the Gila River; on the west by the eastern boundary of their western neighbors; on the east by a line roughly following the western boundary of the Papago Indian Reservation; and on the south by the northern perimeter of Seri Indian territory at some unknown point; and on the southeast in Sonora by the western boundary of riverine-dwelling Pima-speaking Indians."

He later wrote that (Fontana 1989:40) "Although none of the eighteenth- and early nineteenth-century accounts makes mention of the fact, it appears safe to assume that a pattern of living characteristic of Papagos in the late nineteenth century prevailed then – and prehistorically – as well." If this is the case, one wonders what form of use, if any, was undertaken by the Hohokam or Patayan.

Evaluating the location of Fontana's suggested eastern boundary of the western band of Indians (Areneños, Sand Papagos or Hia C-ed O'odham) by examining the distribution of stone spheres is informative (Figure 1). In this study the projects east of the Growler Mountains produced a total of two stone spheres and no cubes. Another sphere was recorded in the canyon connecting the eastern and western sides of the Growler Mountains. In contrast, 241 spheres and all four cubes are west of the Growler Mountains. Granted, more acreage has been surveyed on the west side, but not by much. And consider that 100 spheres and two cubes were discovered during the survey of 12,609 acres immediately west of the Growler Mountains in the Growler Valley. Compare this with the two spheres and no cubes from the 10,200-acre survey on the east side of the Growler Mountains in the Daniels Valley. So, Fontana's proposed boundary line through the Mohawk Mountains to Sonoita, Sonora, Mexico separating the eastern and western bands of western Areneños appears to be remarkably congruent with these distributions, although the line needs to be relocated slightly farther to the east through the Growler Mountains.

Conceivably, other types of artifacts and features may be distributed similarly with respect to the Growler Mountains including the types and quantities of marine shell, the locations of the sources of utilized obsidian, the proportions of ceramic types, the presence or absence of piles of cremated animal bones and piles of bighorn sheep horns, certain types of grinding implements, and the types of ground figures and petroglyphs.

Still unresolved is the question of why so many of these objects are found in the far western deserts, a region thought to have had much lower population densities than areas to the east. Perhaps this is where spheres were more heavily utilized, or perhaps they were manufactured locally and exported, like shell jewelry.

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PITHOUSES OF THE EASTERN PAPAGUERÍA: AN UPDATED REGIONAL TYPOLOGY

John S. Langan

ABSTRACT

In light of recent research, updates are suggested for the regional pithouse typology previously laid out by Arnold Withers and crew after their work at Valshni Village in 1939–1940. Historically, the eastern Papaguería has not been the subject of intensive archaeological study due to the scarcity of large village sites, traditional academic focus on "core" areas and large sites, and lack of development that would prompt compliance-driven archaeology. Recent excavations in advance of highway widening sponsored by the Arizona Department of Transportation and Federal Highway Administration along State Route 86 have yielded some of the only available subsurface data pertaining to small sites in the area between the Tucson Basin and western Papaguería. This paper presents comparative excavation results in support of understanding regional pithouse morphology and correlations to function and temporal association, although a larger data set is needed to more fully explore the topic. The discussion addresses recently discovered structures dating to the Late Archaic/Early Agricultural and Early Ceramic periods, times for which little excavation data was formerly available.

INTRODUCTION

Prior to 2010, few pithouses had been excavated in the non-riverine portions of the eastern Papaguería. Complete measurements were available for fewer than 40 structures. Recent excavations conducted by AZTEC Engineering Group, Inc. (AZTEC) and Desert Archaeology, Inc. (Desert) resulted in the investigation of an additional nine pithouses divided among five separate sites, including the first known pithouses that definitively date to the Late Archaic/Early Agricultural Period (ca. 1800 B.C.—A.D. 150) and the unnamed phase in the local chronology, which corresponds to the Early Ceramic and Pioneer periods in the broader Hohokam chronology (ca. A.D. 150–A.D. 750). This paper seeks to integrate the new data with the temporal pithouse typology devised by Withers (1941) to present a refined schema.

Understanding pithouse morphology and design is an important topic individually, and such information may also assist in addressing a range of research questions pertaining to the region. Architectural style and construction methods are broadly recognized by researchers as being among the most important and useful data sets observable in archaeological contexts. Types and arrangements of pithouses are often used to inform interpretations of site function, and architectural design can be viewed as an indicator of social group organization (see for examples, Feinman et al. 2000; Gilman 1997). Diachronic change in domestic architecture has been viewed as a response to shifting social and environmental pressures (see for examples Ciolek-Torrello 2012; Flannery 1972, 2002; McGuire and Schiffer 1983). Additionally, architectural design is a conservative cultural trait that may be a strong indicator of social identity (see for example Clark 2001).

ENVIRONMENT AND CULTURAL SETTING

Archaeologists have traditionally applied the name "Papaguería" to the area of southern Arizona and northern Sonora roughly bounded by the Gila River to the north, Tucson Basin to the east, Rio Magdalena to the south, and Colorado River to the west (Figure 1). This name is derived from the word "Papago," used by Spanish colonists to refer to the indigenous O'odham residents of the area (MacDougal 1908). The region comprises a large portion of the Tohono O'odham ancestral territory. Today, much of the land—including the area containing all sites discussed in this paper—is subsumed within the Tohono O'odham Reservation.

The region can be subdivided into eastern and western halves based on geographic variability, especially

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Figure 1. Map of the Papaguería. Adapted from Palacios-Fest and Rankin (2008:Figure 42)

with respect to available surface water (see Figure 1). While the entire region is arid and is thought to have had prehistoric occupations characterized by highly mobile populations, the eastern Papaguería's greater availability of surface water led to the establishment of a few village sites that may have been occupied year-round (Masse 1980).

Prior Work and Research Background

Historically, the eastern Papaguería has not been the subject of intensive archaeological study due to the scarcity of large village sites, traditional academic focus on "core" areas and large sites, and lack of development that would prompt compliance-driven archaeology. Since 2010, a series of testing and data recovery projects has been undertaken on behalf of the Arizona Department of Transportation (ADOT) and Federal Highway Administration (FHWA) in advance of road widening along State Route 86 (SR 86) (Figure 2). Data considered in this paper is derived from six prior projects in addition to the SR 86 projects (Table 1).

One of these prior studies, the University of Arizona's excavations at Valshni Village, resulted in an early attempt to characterize pithouse architecture in the region according to temporal phase (Withers 1941). The resulting typology considered only pithouses known from two village sites whose occupations were assigned to the time period between ca. A.D. 850 and 1450 (Colonial through Classic Periods). In contrast, the SR 86 sites appear to be characterized by low-density, temporary occupation typical of resource procurement and processing loci. Four of the sites, AZ AA:14:2(ASM), AZ AA:14:39(ASM), AZ DD:1:75(ASM), and AZ DD:2:53(ASM) have been identified as repeatedly occupied camp sites due to the presence of domestic features, trash mounds, and/or dense and diverse artifact scatters (Cook 2003, 2014, 2015; Langan and Lundin 2017; Stone and Lundin 2017). These sites likely did not experience year-round occupation. Rather, episodic reoccupation over a period of centuries is probable. Each of these sites yielded remains of multiple temporal components, ranging from the Late Archaic/Early Agricultural Period (ca. 1700 B.C.–A.D. 150) to the Protohistoric (A.D. 1450–1697).

Data from the lower Santa Cruz River Valley (in particular, Santa Cruz Flats) and Avra Valley were excluded from consideration. Although these areas are within the area geographically defined as the Papaguería, these sites are markedly different from those situated in the non-riverine interior of the region and exhibit characteristics that might be considered transitional between the eastern Papaguería and Tucson Basin or Gila River Hohokam material culture. Sites excavated for the Tucson Aqueduct portion of the Central Arizona Project, for example, were interpreted as having a basically riverine Hohokam character in spite of lacking a proximal waterway (Ravesloot 1989). While comparisons with these data would be valuable, that is not the subject of this paper.

Chronology and Culture History

A culture history was developed for the SR 86 projects, relying on archaeological interpretations from prior projects (Cook 2014; Langan and Lundin 2017). Table 2 presents chronological phases defined for the Papaguería in relation to the broader regional periods and phases for the Tucson and Salt River Basins, geographic regions that became the foci of Hohokam society. While this chronological scheme requires refinement and updates, it is used herein to maintain consistency with prior research.

Cultural Affiliation

Archaeological understanding of the eastern Papaguería during the span between roughly A.D. 100 and A.D. 1450, especially during the Pre-Classic, is plagued by a persistent question of whether or not its occupants should be viewed as Hohokam. Some Hohokam elements are present (ie, red-on-buff, red-on-brown, and redware ceramics; pithouse architecture; dry farming and floodwater maize cultivation), while others are lacking (most conspicuously, ballcourts and/or

Table 1. Summary of Selected Projects.

Project Name	Sites with Architectural Features Investigated	Number of Pithouses Investigated	Reference
Jackrabbit Ruin	AZ DD:1:6(ASM)	11	Scantling 1939, 1940
Valshni Village	AZ DD:1:11(ASM)	28	Withers 1941, 1944
Santa Rosa Wash	AZ AA:5:43(ASM)	1	Raab 1974
Sells Wastewater Treatment Facility	AZ DD:1:22(ASM)	1	Roberts and Gregonis 1996
Cyprus Tohono Mine	AZ AA:5:145[ASM]	1	Roberts & Ahlstrom 2001
TOUA Fiber Optic Line	AZ DD:2:53(ASM)	1	Cook 2003
SR 86; San Pedro	AZ AA:14:39(ASM)	3	Cook 2014
SR 86; Santa Rosa Ranch	AZ AA:14:2(ASM)	3	Cook 2015
SR 86; Sells to Fresnal	AZ DD:1:75(ASM)	1	Stone and Lundin 2017
SR 86; Fresnal to MP 123.9	AZ DD:1:77(ASM)	1	Langan and Whitney, in prep.

platform mounds). A few Papaguerían cultural traits are contradictory to Hohokam practices, such as an apparent emphasis on inhumation vs. cremation mortuary practice, subsistence and settlement strategies emphasizing mobility, and a very low incidence of decorated pottery. This state of affairs has been variously interpreted to represent a "Desert Branch" of the Hohokam closely related to the occupants of the Salt, Gila, and Santa Cruz River Valleys but having regionally distinctive material culture (c.f., Haury 1950; Scantling 1940; Withers 1941, 1944), a group influenced by but culturally separate from the Hohokam (c.f., DiPeso 1956; Hayden 1970; Rosenthal et al. 1978), or the result of disjunctive land use among Hohokam people whose principal villages were along the Gila River undertaking seasonal forays into the Papaguería to collect wild resources and grow maize along the washes (Masse 1991). For the purposes of this discussion, a definitive answer to the question of cultural affiliation is not immediately relevant. Increased understanding of pithouse morphology may ultimately help to resolve this question.

Current Understanding of Eastern Papaguería Pithouse Architecture

Papaguerían pithouses conform to the general character of single-room residential structures used throughout prehistory in the greater Southwest, although their remains have often been observed to appear more eroded and contain fewer artifacts than their counterparts in more densely occupied areas like the Gila, Salt, and Santa Cruz river valleys. As is usually the case, idiosyncratic architectural characteristics have been identified as local variations on the overall pithouse theme.

Following excavations at Valshni Village, Arnold Withers (1941, 1944) outlined a typology for assigning these region-specific traits to temporal categories (Figure 3). This preliminary seriation of pithouse architecture was necessarily defined based on a small sample. Twenty-eight pithouses were identified at Valshni, only 12 of which were sufficiently intact to obtain complete measurements (Withers 1941, 1944). The Sells Phase was characterized by 11 discrete residential units at Jackrabbit Ruin, from which excavators were able to obtain maximum dimensions for two. Withers' typology

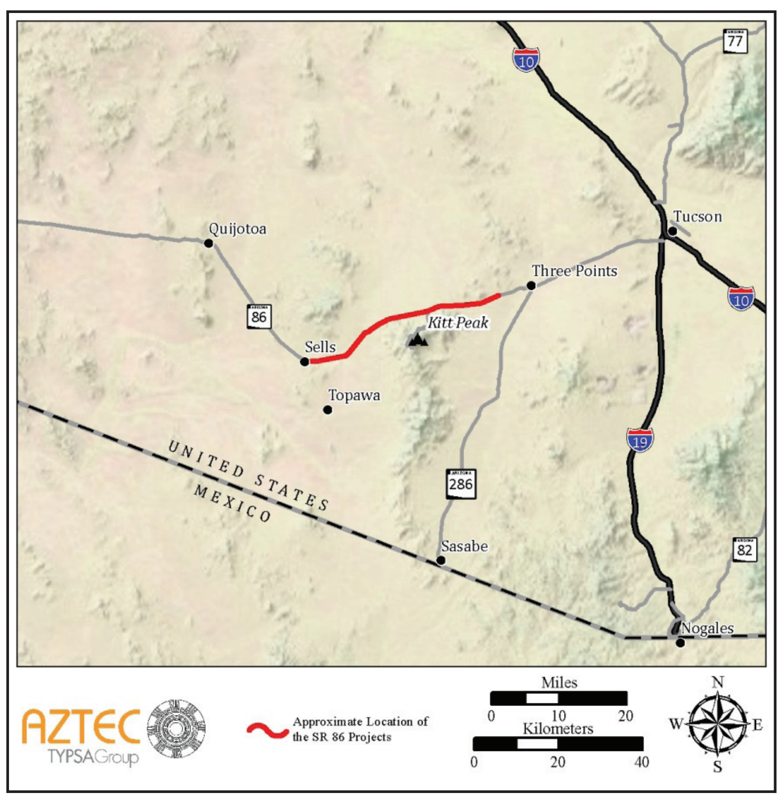

Figure 2. Approximate location of the SR 86 projects.

applied only to temporal phases within the Sedentary and Classic periods (A.D. 900–1450), as no other time periods were represented in the sample available at the time. Structures at both sites were dated via ceramic seriation; no direct dating methods were employed.

In all the pithouses at Jackrabbit and Valshni, several common elements were observed. Floors were universally prepared with clay plaster. Floor artifact assemblages were sparse. Interior hearths, when present, were centrally positioned along the structures' long axis and typically offset toward the entryway along the short axis. Hearths were universally plastered. Evidence for wall and roof construction method and form was lacking, but Withers (1941) supposed that superstructures were fashioned from sticks and brush in a manner resembling traditional O'odham houses. Postholes were usually present and normally included a central post plus an irregular arrangement of perimeter posts. Floor grooves were absent. The structures were evidently very shallow, more like surface-sitting brush shelters than pithouses; Withers (1944:39) likened them to "Woodward's Type A at Grewe," (see Woodward 1931:10). Some attributes, especially shape, size, and hearth and entryway configuration, were viewed as being temporally diagnostic.

Very few pithouses have been found during subsequent excavation projects. Despite having been identified as a village site that may have been occupied on a permanent basis, Gu Achi was found to include no intact pithouse remains during Masse's (1980) investigations. Three single-household pit structures are known from other projects; these include one each from the Quiput Site (AZ AA:5:145[ASM]) (Roberts and Ahlstrom 2001), AZ AA:5:43(ASM) (Raab 1974), and AZ DD:1:22(ASM) (Roberts and Gregonis 1996). Of these, only one yielded a reliable date; the AZ DD:1:22(ASM) structure was assigned to the Vamori Phase based on radiocarbon dating. Like contemporaneous examples from Valshni Village, this structure was oval, had a central plastered hearth, and similarly arrayed postholes (Figure 3); however, this structure was smaller and lacked a prepared floor.

New Data

The sample of newly excavated eastern Papaguería pithouses helps fill the gaps in Withers' typology. The new sample of pithouses consists of nine structures divided among five sites investigated during the SR 86 projects (Figure 4; Table 3).

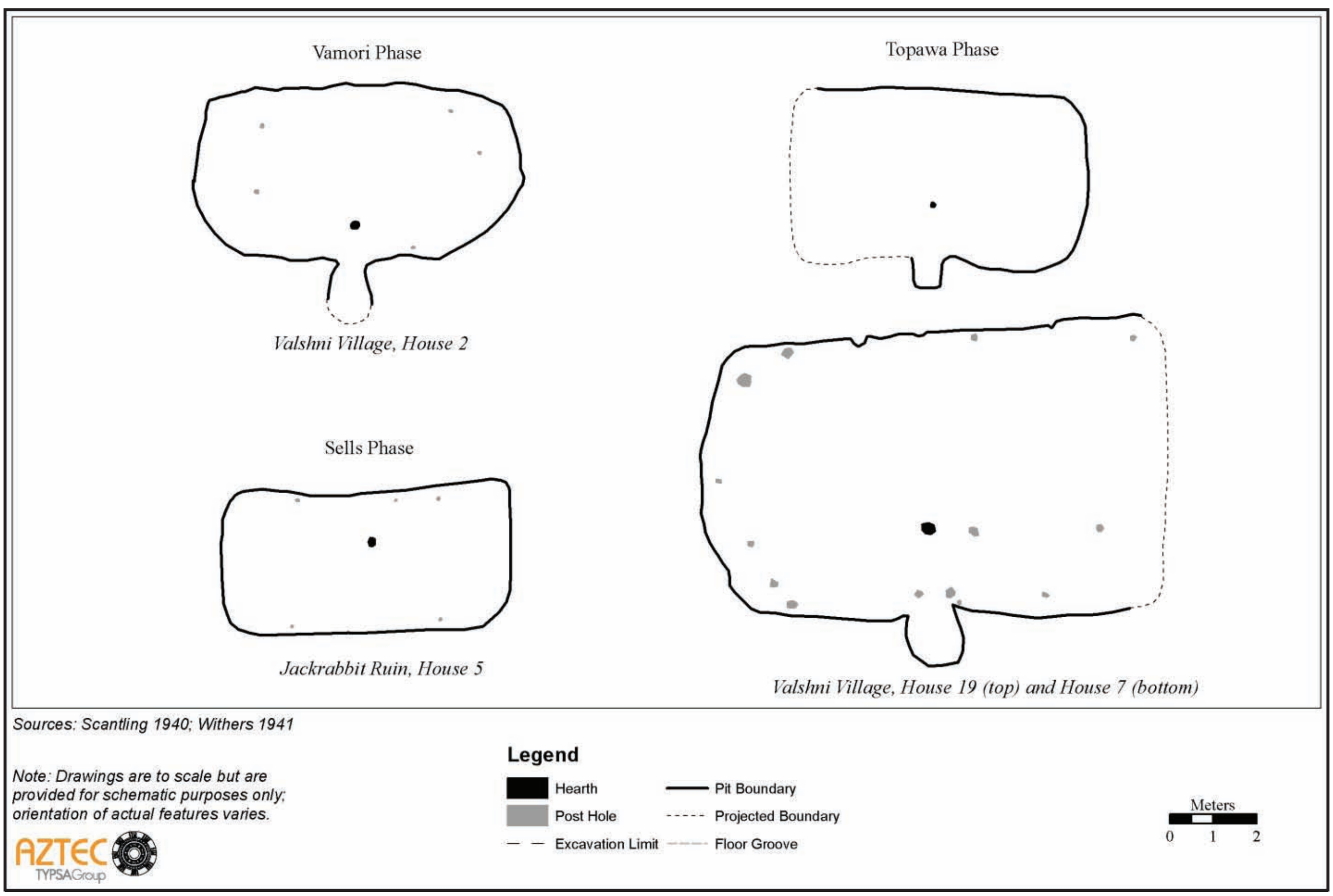

Figure 3. Sample of Vamori, Topawa, and Sells Phase pithouses, as outlined by Withers (1941).

Table 2. Chronology for the Papaguería, Tucson Basin, and Salt River Basin. (compiled from Cook 2014; Langan and Lundin 2017)

Year	Chronological Periods	Salt River Basin	Tucson Basin	Papaguería
A.D. 1900	Historic	Akimel O'odham and Euro-American	Tohono O'odham, Spanish, and Euro-American	Tohono O'odham, Spanish, and Euro-American
A.D. 1800				
A.D. 1700	Protohistoric	Akimel O'odham	Tohono O'odham and Sobaipuri	Tohono O'odham
A.D. 1600				
A.D. 1500				
A.D. 1400	Classic	Polvorón (?)	Tucson	Sells
A.D. 1300		Civano		
A.D. 1200		Soho	Tanque Verde	Topawa
A.D. 1100	Sedentary	Sacaton	Late Rincon	Vamori
A.D. 1000			Middle Rincon	
			Early Rincon	
A.D. 900	Colonial	Santa Cruz	Rillito	Gila Butte
A.D. 800		Gila Butte	Cañada del Oro	
A.D. 700	Pioneer	Snaketown	Snaketown	unnamed
		Estrella/Sweetwater	Tortolita	
A.D. 600	Early Ceramic	Vahki	Late Agua Caliente	
A.D. 500				
A.D. 400				
A.D. 300			Early Agua Caliente	
A.D. 200		Red Mountain		
A.D. 100				
100 B.C.	Early Agricultural/ Late Archaic	—	Late Cienega	San Pedro / Amargosa III
500 B.C.			Early Cienega	
1000 B.C.			San Pedro / unnamed	
2000 B.C.	Middle Archaic	—	Chiricahua	Chiricahua/Amargosa II
3000 B.C.			Occupation gap (?)	Ventana/Amargosa I
5000 B.C.				Occupation gap (?)
7000 B.C.	Early Archaic	—	Sulphur Springs	Ventana
9000 B.C.	Paleoindian			
10,000 B.C.				

Pithouse Characteristics by Temporal Period: Data Integration

Addition of the new data makes it possible to expand Withers' (1941) typology to include pithouse forms present in the eastern Papaguería prior to the Vamori Phase and to refine the earlier view of Classic Period pithouses. Table 4 summarizes these characteristics, and examples are illustrated in Figure 5.

Late Archaic/Early Agricultural Period

The three pithouses discovered at AZ AA:14:39(ASM) dated to the Late Archaic/Early Agricultural Period based on the presence of a San Pedro projectile point (1200–800 BC) within Feature 21, the proximity and similarity of the three structures, and radiocarbon dates taken from nearby pit features (Cook 2014). All are small, having a maximum horizontal dimension of 3.15 m, and are either circular or subrectangular (Figure 4). The structures were heavily eroded and difficult to identify, their presence made apparent mainly by the fact that the pits were dug into a layer of Pleistocene caliche. Postholes were present in only one structure (Feature 45). These were aligned along one side of the structure. The structures included no evidence of prepared floors, subfloor pits, or any other sort of subfeatures; however, due to the high level of rodent disturbance, it was unclear if any such subfeatures ever existed or were, perhaps, destroyed after abandonment.

Table 3. Summary of SR 86 Pithouses.

Site (citation)	Feature Number	Plan Shape	Length (m)	Width (m)	Depth (m)	Floor Area (m2)	Floor Preparation	Interior features	Floor Artifacts	Entryway	Temporal Association (source)
AZ AA:14:2(ASM) (Cook 2015)	5	Subrectangular	4.9	3.4	0.18	14.11	No	One central posthole; floor groove with 16 post holes, informal hearth (charcoal stain), subfloor storage pit	Extensive domestic assemblage	None defined	A.D. 1100–1450, Topawa or Sells Phase (ceramics on floor and in fill)
	9	Oval	3.94	3.27	0.11	11.4	No	One central and seven perimeter postholes	No	None defined	A.D. 675–780/790–870; unnamed, Gila Butte, or Vamori phase (radiocarbon date from Acacia charcoal); A.D. 1100–1450, Topawa or Sells Phase (proximal features, overall site dates)
	12	Subrectangular	3.6	3.5	0.04	15.61	No	Plastered hearth	Sparse ceramic and flaked stone items	None defined	A.D. 1100–1450, Topawa or Sells Phase (archaeomagnetic date coupled with ceramic dating from overall site)
AZ AA:14:39(ASM) (Cook 2014)	11	Subrectangular	3.15	2.15	0.23	5.29	No	None	No	None defined	1200–800 BC, Late Archaic/Early Agricultural Period (similarity and proximity to F. 21)
	21	Circular or oval	2.45	1.9	0.22	4.32	No	None	No	None defined	1200–800 BC (San Pedro Point in fill)
	45	Circular	1.75	1.65	0.26	2.32	No	4 post holes arranged in a line along north side	No	None defined	1200–800 BC, Late Archaic/Early Agricultural Period (similarity and proximity to F. 21)
AZ DD:1:75(ASM) (Stone & Lundin 2017)	63	Subrectangular	Ca. 4.75*	1.75	0.11	4.37	No	Shallow, basin-shaped hearth	Mano fragment and core	East-facing; probably positioned centrally along wall; could not be determined due to partial exposure	Likely A.D. 650–770, unnamed phase (radiocarbon dates from nearby pit features and ceramics) ***

Table 3. Summary of SR 86 Pithouses (continued).

Site (citation)	Feature Number	Plan Shape	Length (m)	Width (m)	Depth (m)	Floor Area (m2)	Floor Preparation	Interior features	Floor Artifacts	Entryway	Temporal Association (source)
AZ DD:2:53(ASM) (Cook 2003)	1**	unknown	N/A	N/A	0.37	unknown	No	None encountered in control unit	Sherds, mortar, deer antler	None defined	A.D. 1260–1310; A.D. 1270–1400 (2 samples)
AZ DD:2:77(ASM) (Langan & Whitney, in prep.)	13	Subrectangular	Ca. 5.75*	2.8	0.13	13.45	Yes, plastered	Floor groove with post holes, hearth	Sparse ground stone tools, cores, and sherds	None defined due to partial exposure; probably existed along west wall	A.D. 382–538, unnamed phase (radiocarbon date; charred annual plant tissue recovered from hearth fill in flotation)

* These measurements are estimates extrapolated from partial exposures; remaining portions of these features could not be excavated due to overlapping utilities or safety constraints.
**Feature was not fully excavated; information presented here is the product of profile exposure in a backhoe trench and manual excavation of a 1-×-2-m control unit that exposed a portion of the floor.
***Radiocarbon data were obtained from four nearby pits, three of which returned dates ranging from A.D. 650 to 770. The fourth pit, however, dated to A.D. 1040-1220. It is inferred based on this 3:1 ratio that the pithouse at AZ DD:1:75(ASM) most likely represents the earlier occupation.

The subrectangular house at AZ AA:14:39(ASM) (Feature 11) may represent a functionally or culturally different style; however, such an interpretation is hampered by the dearth of artifactual contents. Late Archaic/Early Agricultural houses of comparable size and shape have been excavated elsewhere in the greater southwest, though circular forms are more common (Mabry 1998:219).

Early Ceramic Period/Unnamed Phase

The unnamed phase in the Papaguerían chronology spans ca. A.D. 150 and A.D. 750. Prior to Desert's Fiber Optic project (Cook 2003), no sites had been dated to this period in the eastern Papaguería. That project encountered a pithouse at AZ DD:2:53(ASM), which was sampled. The SR 86 projects produced the region's first 100-percent excavations for pithouses of this period.

Structures from this period were found at AZ DD:1:75(ASM) (Feature 63; Stone and Lundin 2017) and AZ DD:2:77(ASM) (Feature 13; Langan and Whitney, in prep.). Both are subrectangular structures with horizontal dimensions ranging from 4.75 to 6.0 m. Feature 63 at AZ DD:1:75(ASM) has an informal character with an unprepared floor, small, unlined hearth, and no discernible postholes. In contrast, Feature 13 at AZ DD:1:77(ASM) is a clear example of house-in-pit construction, with postholes situated along a floor groove running the entire periphery of the structure. It includes remnants of a plastered floor, a central posthole, and an interior hearth, from which a radiocarbon date of A.D. 382–538 was obtained from charred annual plant tissue.

Feature 13 at AZ DD:1:77(ASM) is the earliest known instance of a house-in-pit with a complete perimeter floor groove in the eastern Papaguería, and it appears to be an early example of this form across the broader region (Langan and Whitney, in prep.). Mabry (1998:225–226) explains that floor grooves were rare among Late Archaic occupations in the Tucson Basin, but these features are frequently encountered in Pioneer and Colonial contexts (c.f., Whittlesey 2013).

It is unclear if the differences between these two structures are cultural or functional. Based on the recovery of several maize cupules from nearby pits, the structure at AZ DD:1:75(ASM) may represent a field house rather than a typical residential structure. Although both houses date to the Unnamed phase of the Early Ceramic Period, their occupations were separated by at least 150 years.

Colonial Period/Gila Butte Phase

No data are currently available to characterize pithouses of this era. A ramada and associated pit features dating to this time were excavated at Gu Achi (Masse 1980).

Table 4. Summary of Pithouse Attributes by Temporal Phase.

Period/Phase	Number of Features*	Plan Shape	Length in meters (minimum–maximum)	Width in meters (minimum–maximum)	Floor Area in sq. meters (minimum–maximum)**	Pit Construction Style	Entryways	Hearths	Floor preparation	Postholes	Floor Groove
Late Archaic/ Early Agricultural (1800 B.C.–ca. A.D. 150)	3	Circular or Subrectangular	1.75–3.15	1.65–2.15	2.32–5.39	Steep-sided pit ca. 0.25 m in depth	None apparent	None	Unprepared	Indiscernible or aligned along one side of structure	Absent
Unnamed Phase (Early Ceramic/Pioneer; ca. A.D. 150–750)	2	Subrectangular	Ca. 4.75–6.0	1.75–2.80	4.37–13.45	Steep-sided pit 0.11–0.13 m in depth; one clear example of house-in-pit construction	Probably centrally positioned along one long axis wall	Centrally positioned, irregular, sometimes plastered, basin-shaped, shallow (3–8 cm)	Sometimes prepared with clay plaster	Indiscernible or at least one central posthole with radial perimeter posts set in floor groove	Sometimes present; full perimeter
Gila Butte (A.D. 750–900)	0	Unknown	N/A	N/A	Unknown	Unknown	Unknown	Unknown	Unknown	Unknown	Unknown
Vamori (A.D. 900–1100)	22	Oval to subrectangular; rarely oval to nearly circular	4.0–8.4	3.6–5.4	Ca. 14.0–41.0	Very shallow or no pit	Usually oval, centrally positioned along one long wall, sometimes stepped or straight-sided	Centrally positioned, irregular, deep (5–13 cm), steep-sided, plaster-lined, lip raised above floor grade	Clay plaster; rarely unprepared	Usually one central post with an irregular arrangement of perimeter posts	Absent
Classic Period, undifferentiated phase (A.D. 1100–1450)	3	Oval to subrectangular	3.6–4.9	3.27–3.5	11.40–15.61	Steep-sided pit 0.11–0.18 m in depth or very shallow pit; one clear example of house-in-pit construction	None apparent	Plastered or informal and irregular	None	Indiscernible, or at least one central posthole with radial perimeter posts that are sometimes set in a floor groove	Sometimes present; full perimeter

Table 4. Summary of Pithouse Attributes by Temporal Phase (continued).

Period/Phase	Number of Features*	Plan Shape	Length in meters (minimum–maximum)	Width in meters (minimum–maximum)	Floor Area in sq. meters (minimum–maximum)**	Pit Construction Style	Entryways	Hearths	Floor preparation	Postholes	Floor Groove
Topawa (A.D. 1100–1250)	7	Subrectangular	6.2–8.4 or 9.2–10.5***	3.6–5.4 or 5.85–6.1***	Ca. 20.40–42.6 or 50.4–60.70***	Very shallow or no pit	Oval, centrally positioned along one long wall	Centrally positioned, symmetrical and smooth, shallow (4.3–8 cm), lip sharp and even with floor grade	Clay plaster	Usually one central post with an irregular arrangement of perimeter posts	Absent
Sells (A.D. 1250–1450)	11	Oval to subrectangular	6.3–6.9	3.1–3.3	Ca. 17.70–22.10	None; surface feature	None	Centrally positioned, irregular, deep (5–13 cm), steep-sided, plaster-lined, lip raised above floor grade	Clay plaster	One main supporting post in each corner	Absent

* Sources: Cook 2014, 2015; Goodyear 1975; Langan and Lundin 2017; Langan and Whitney in prep.; Roberts and Ahlstrom 2001; Roberts and Gregonis 1996; Scantling 1940; Stone and Lundin 2017; Withers 1941
** Withers (1941) and Scatling (1940) did not provide measurements of floor area; approximate measurements in this column are derived from estimates made by the author using figures presented in the respective reports.
***Withers (1941, 1944) alludes to these larger structures as possibly representing communal structures or an otherwise functionally differentiated type

Sedentary Period/Vamori Phase

Withers (1941) noted broadly similar characteristics for all houses belonging to Sedentary and Classic period phases. He differentiated Vamori houses by their variable oval or subrectangular shape, roughly consistent size, and deep interior hearths.

Among the SR 86 data, Feature 9 at AZ AA:14:2(ASM) is the only candidate for a Vamori Phase pithouse (Cook 2015), but it does not conform to Withers' (1941) established parameters for the time. Furthermore, the radiocarbon date obtained from this feature did not concord with any other dates obtained from the site, and excavators ultimately assigned the feature to the Classic Period (Cook 2015).

Classic Period/Topawa and Sells Phases

At Valshni Village, Withers (1941) identified Topawa Phase houses as being broadly similar to Vamori houses but with greater tendency toward rectilinearity with rounded corners. He also identified two noticeably larger structures, which he speculated might be of a functionally different type, such as a communal structure.

At site AZ AA:14:2(ASM), Cook (2015) encountered three pithouses dating to the Classic Period that do not conform to any of the previously known Papaguerían Classic Period types. One of these, Feature 5, was similar in form to the Early Ceramic Feature 13 at AZ DD:1:77(ASM), exhibiting a house-in-pit construction method. AZ AA:14:2(ASM) Feature 5 was slightly smaller and the pit slightly deeper. The floor assemblage was extensive and included artifacts clearly diagnostic of the Classic Period, unlike the AZ DD:1:77(ASM) pithouse.

The other two structures at AZ AA:14:2(ASM) were considerably closer in form to the known Topawa Phase structures, utilizing a shallow pit and a central post with radially arranged perimeter posts. Both structures are smaller than the previously known examples of this period, and one (Feature 9) is oval-shaped, a deviation from Withers' (1941) observations.

Late Classic Period architecture is most commonly typified by the multi-room, above-ground, adobe-walled compounds or "enclosures" excavated at Jackrabbit Ruin, but that site also yielded 11 pithouses (Scantling 1940). The pithouses are similar to those belonging to the Topawa

Phase but are differentiated by the use of corner posts rather than central posts as the primary superstructure supports. Sells Phase houses also lack the covered entryway common to earlier structures.

SUMMARY AND CONCLUSIONS

When Withers (1941) defined the preliminary architectural typology for the Papaguería, he noted its reliance on a small sample and identified the need for more data to complete the work. Although the SR 86 data adds additional information for the temporal periods the earlier typology could not address for lack of information, the sample remains quite small. At present, this expanded typology can only serve as a baseline classificatory tool; definition of functional types and a more refined chronological typology still require a larger data set. Furthermore, anthropological significance cannot be currently ascribed to the variability evident in this data set. This typology cannot be used to differentiate culturally or functionally distinct categories, aside from reaffirming a sharp distinction between Late Archaic/Early Agricultural and Early Ceramic architecture, an observation that is already well documented. It is hoped that the information presented herein will serve those goals in the future, especially in combination with data gathered by future projects and in combination with other lines of evidence.

Continued development of this pithouse typology will allow comparisons with surrounding regions and help address questions pertaining to the identity, movement, and interactions of prehistoric Papaguerínas. Additionally, it should promote a more thorough understanding of regional chronology. As currently defined, the unnamed phase (A.D. 100–700) spans nearly 80 percent of the first millennium A.D. This era especially requires much more evaluation to adequately characterize it, a fact that is underscored by the recent SR 86 projects. The data set presented here includes two dissimilar pithouses from this era whose occupations are separated by at least 150 years. Elsewhere in the Hohokam world, these would be treated as part of entirely different temporal phases based on significant shifts in material culture, and it may be the case that this phase should be further subdivided for the eastern Papaguería as well.

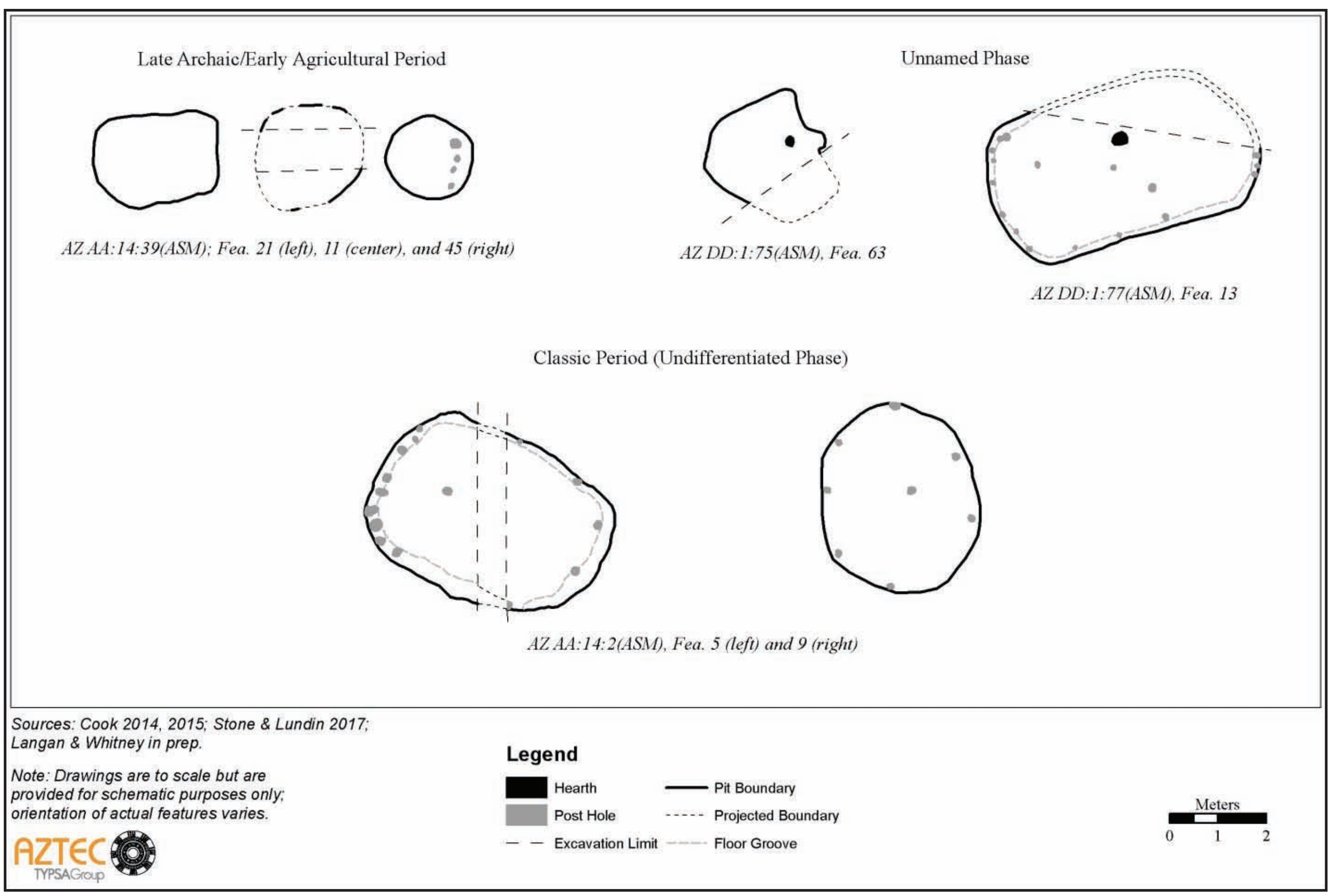

Figure 4. Sample of pithouse types found during the SR 86 projects, derived from Cook (2014, 2015), Langan and Whitney (in prep.), and Stone and Lundin (2017).

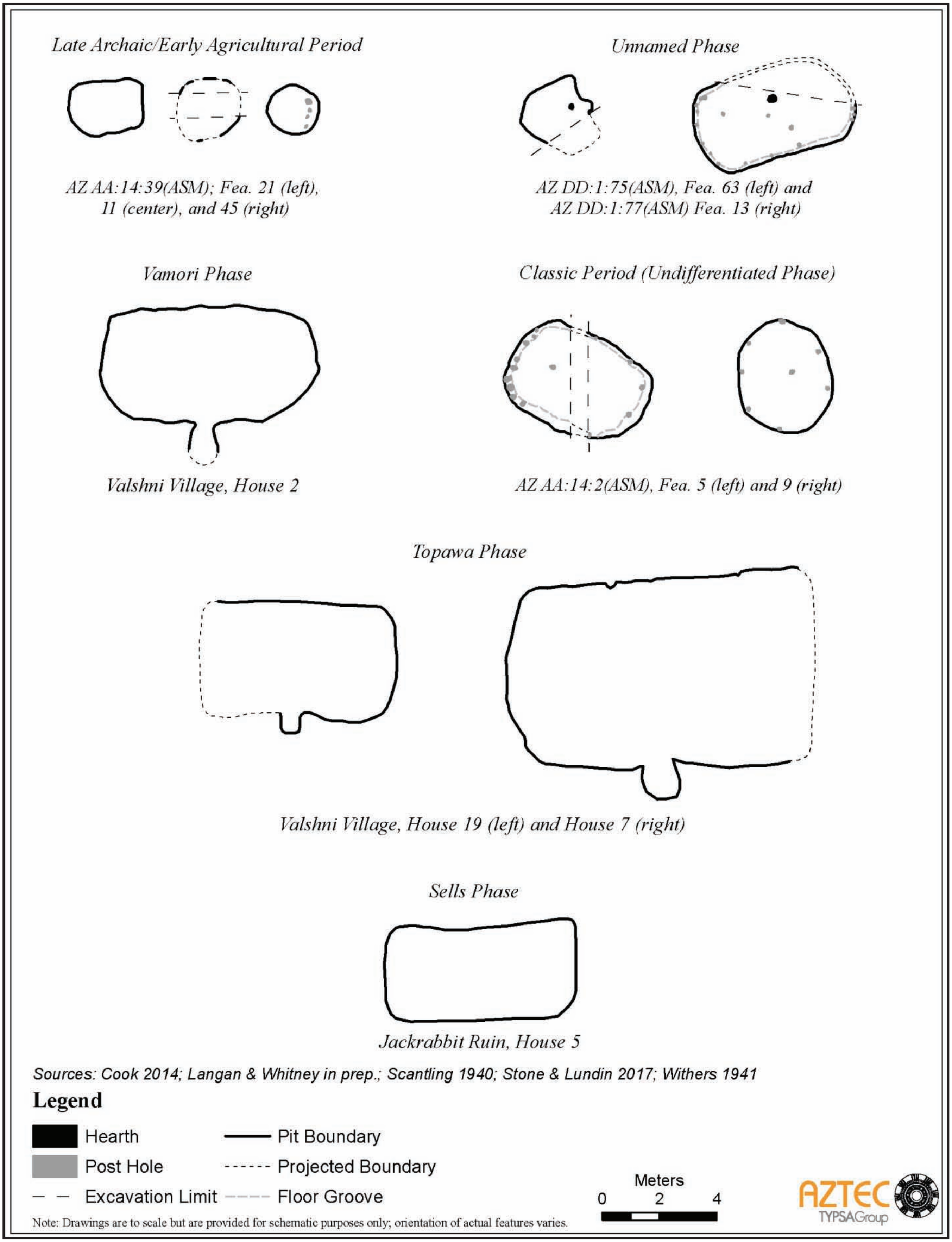

Figure 5.Representative examples of the pithouse typology presented herein.

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AN EVALUATION OF ANCESTRAL PUEBLO SETTLEMENT AND LAND USE PATTERNS OVER TIME IN THE HAY HOLLOW VALLEY OF EASTERN CENTRAL ARIZONA

Abraham Arnett

ABSTRACT

A synthesis of previous archaeological investigations combined with archival research and GIS- (geographic information systems) based analysis of Ancestral Pueblo archaeological sites in the Hay Hollow Valley of east central Arizona reveal changes in settlement and land use over time. Apparent increases in population, presumably linked with the transition from hunting and foraging to farming maize, a phenomenon demonstrated across much of the Prehispanic Southwest, may have led to increasing competition for finite natural resources including perennial water and arable land. Previous research projects in the Hay Hollow Valley, primarily the Field Museum's Southwest Archaeological Expedition, have produced a wealth of archaeological site data. In particular, the data reveal strong patterns of settlement and land use over time, shifts in settlement likely associated with changes in subsistence strategies, the development of technological innovations designed to control the flow of water, and evidence of complex systems of community integration that challenges previously held notions of small, autonomous farmers living in an area peripheral to other, more densely populated areas of the American Southwest. Rather than competition, the results of the analysis suggest that interdependence and adaptability may have been driving changes in Ancestral Pueblo social organization between about AD 100 and 1325 in the Hay Hollow Valley.

Archaeological and environmental research in the American Southwest has provided important information regarding human adaptations to environmental changes and resource scarcity (e.g., Cordell and Plog 1979; Dean et al. 1985; Gummerman 1988; Hegmon et al. 2008; Peeples et al. 2006; Plog 1974; Zubrow 1971). However, in many parts of the Southwest, archaeologists have yet to synthesize previously published and unpublished archaeological data and use Geographic Information Systems (GIS) based analysis to investigate the changing relationship between humans and the environment over extended periods of time. The southwest Cibola region of eastern Central Arizona, a term used to denote the approximate extent of broad patterns in architectural styles and artifact assemblages from about AD 100 to about AD 1400, serves as a primary example (Figure 1).

Based on recent thesis research (Arnett 2016), the present study examines changes in the settlement and land use of Ancestral Pueblo populations living in the Hay Hollow Valley of east central Arizona between approximately AD 100 and 1325. Exploratory data analysis indicates that increasing demand for arable land and access to permanent water may have resulted in changes in social organization including shifts in settlement patterns, land use patterns, and technological innovations across different environmental zones over time. Changes in settlement and land use include the expansion of people into areas more marginal for floodwater farming, a method identified both archaeologically and ethnographically at Hopi (Cutright-Smith 2007), while technological innovations include the construction of irrigation and water control features. Changes in settlement and land use patterns may also reflect other changes in social organization designed, at least in part, to mitigate the effects of environmental degradation and resource scarcity.

Although over the last 60 years several archaeological research projects have taken place within and around the Hay Hollow Valley (Hartman et al. 1983; Herr 2013, 2015; Neily 1984, 1988, Rogge et al. 2015; Van Keuren 2006; Weaver 1998), none compare with the Field Museum's Southwest Archaeological Expedition, hereafter referred to as "the Expedition." Under the direction of Paul S. Martin, archaeological research included intensive archaeological survey of over 25 square kilometers and the excavation of numerous Ancestral Pueblo sites of various types dating to different time periods (Fritz 1974; Hill 1970; Longacre 1962, 1970; Martin et al. 1962; 1964; 1967; 1975; Plog 1974; Rogge et al. 2015; Zubrow

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1971). The data gathered by the Expedition, combined with the significant time depth of the archaeological record, makes the Hay Hollow Valley an ideal setting in which to study changes in Ancestral Pueblo settlement and land use patterns over time.

SETTING

The Hay Hollow Valley lies near the southern edge of the Colorado Plateau. To the north and east the Little Colorado River flows, and 30 kilometers to the south the White Mountains rise up to meet with the Mogollon Rim. Beginning at the southern end of the valley, the Hay Hollow Draw flows north to join with the Little Colorado River.

The Hay Hollow Valley is situated within the ecotone between the juniper savanna and the pinyon juniper woodland vegetation communities (Neily 1984, Table 2). Trees in the ecotone include both one-seed juniper (*Juniperus monosperma*) and Colorado pinyon (*Pinus edulis*). Woody shrubs include mormon-tea, narrow-leaf yucca, sand sagebrush, fremont barberry, alder-leaf mountain mahogany, cliffrose, and rabbitbrush, to name a few. Various perennial grasses, like grama grass, and forbes such as goosefoot, make up the rest of the plants in the juniper savannah and pinyon juniper woodland vegetation communities.

Bowman (1975:12) writes "the region is semi-arid with a summer dominant rainfall pattern. Kaldahl and Dean (1999) further state that precipitation in the Mogollon Rim area of eastern Arizona is more abundant and more predictable than other lower elevation areas. According to Neily (1984:3) "the average annual precipitation probably ranges from approximately 12 inches at the lower elevations north of Snowflake to possibly 18 inches or greater in the upland areas," and "the annual growing season extends similarly from around 132 days in the lower tableland areas to under 120 days at elevations greater than 1,890 m (6,300 feet)."

For the purposes of this study the Hay Hollow Valley is divided into six environmental zones (Table 1). Environmental zones include the floodplain, floodplain margins, slopes of Black Mesa, the top of Black Mesa, stair step mesas, and ridges (Table 1). Arable land with well-developed soils and permanent water flowing in perennial drainages was more readily available in the flood-

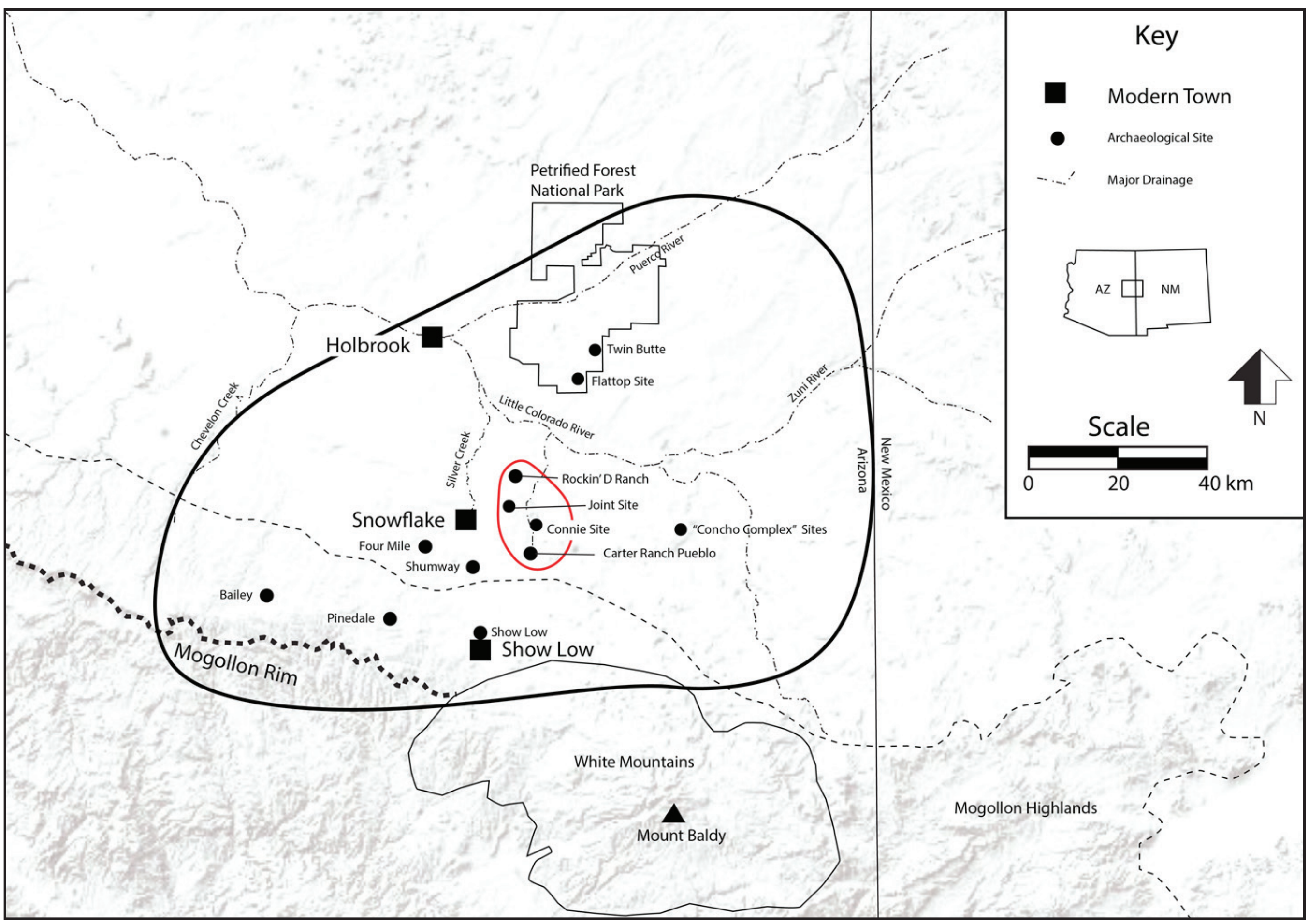

Figure 1. Southwest Cibola region. Solid black outline shows approximate boundary with the Hay Hollow Valley outlined in red.

Table 1. Definitions of Environmental Zones.

Environmental Zone	Definition
Floodplain	Any portion of the study area adjacent to a watercourse that extends from the banks of its channel to the base of another, higher elevation landform. Floodplain areas within the study area generally have a slope of less than 3 degrees and experience flooding during periods of high discharge.
Floodplain Margins	Areas adjacent to and slightly higher in elevation than floodplains generally with a slope of between 3 and 6 degrees.
Ridges	Slopes and crests of hills generally located in the northern portion of the study area, and adjacent to floodplains and floodplain margins.
Slopes of Black Mesa	Any portion of the basalt capped lava tongue known as Black Mesa extending from the bottom of the landform, typically adjacent to the floodplain and floodplain margins, to the top.
Top of Black Mesa	Any portion of the top of the basalt capped lava tongue known as Black Mesa. The top of Black Mesa slopes gently to the north and exceeds an elevation of 1840 meters above sea level beginning at the northern tip of the mesa.
Stair Step Mesas	Any area of elevated land with a flat top and sides formed by horizontal beds of sandstone overlaying steep talus slopes.

plain and floodplain margins than in the upland areas of the valley, mesa slopes, and on mesa tops. As a result, given enough annual precipitation and relatively low population density, floodwater farming agriculture, as in other parts of the Colorado Plateau (Cutright-Smith 2007:42), would have been more favorable in the floodplains and the floodplain margins than in other environmental zones (Stuart 2014:62).

In and around the Hay Hollow Valley, human occupation began as early as the Early Archaic period (ca. 8500 to 3500 BP, Hartman et al. 1983; Martin and Rinaldo 1960). Evidence of maize cultivation found at the County Road Site and the Hay Hollow Site demonstrates that by about AD 100 or 300 people living in the Hay Hollow Valley began farming maize (Bohrer 1972; Martin 1965 NSF Interim Report, Box 41, Paul Sydney Martin, Southwestern United States Archaeological Expeditions, Field Museum Papers, 1930-1977, Field Museum Papers, 1930-1977, Field Museum Library Archives. Chicago, Illinois, but see Arnett 2016:92-94; Berry 1982; Fritz 1974; but see Smiley 1985). Based on the plant remains from Webb Tank, the Connie site (Diehl 2015:294-295; Rogge et al. 2015), Carter Ranch Pueblo (Culter 1964) and Broken K Pueblo (Martin 1967a:52), it appears that over the next five centuries agricultural practices intensified until the valley was abandoned around AD 1325.

METHODS

In order to evaluate changes in Ancestral Pueblo settlement and land use over time in the Hay Hollow Valley between AD 100 and 1325, I analyzed site attribute data including site type, location, estimated or actual period of occupation based on temporally diagnostic artifacts or absolute dates, and estimated or actual number of pit structures or surface rooms for 419 settlements and limited activity sites. These data were compiled by dozens of individuals at various times over the last 60 years (Bohrer 1972; Bowman 1975; Bryce and Arnett 2016; Fritz 1974; Gregory 1975; Hill 1968, 1970; Longacre 1964a, 1967, 1970; Martin 1967a; 1967b; 1972; Martin et al. 1962; 1964; 1967; 1975; Plog 1974; Rogge et al. 2015; Wilcox 1975; Zubrow 1971). The archaeological sites are located within a 99 sq km study area encompassing most of the Hay Hollow Valley, and small portions of Millet Swale and West Hay Hollow Draw (Figure 2).

Archaeological site attribute data was obtained from four different sources and evaluated for quality and comparability based on the types of data collected, methods of data collection, and their relevance to the current study. First, a comprehensive literature review allowed for the compilation of temporal and spatial data from published and unpublished excavation and survey documentation. Second, archaeological survey of a small, non-random sample of private land in and around the Hay Hollow Valley confirmed the locations and attributes of a small sample of previously recorded archaeological sites and led to the identification of previously undocumented sites. Third, additional data was compiled from unpublished primary source material curated as part of the Paul S. Martin Field Museum Papers, a part of the Field Museum Library Archives at the Field Museum in Chicago, Illinois. Finally, a comprehensive reevaluation of the cultural chronology of the Hay Hollow Valley verified or refined the temporal ranges for sites and dated ceramic types included in the dataset (Arnett 2016).

The literature review included temporal and spatial data from published and unpublished excavation and survey documentation assembled from a variety of secondary source material (see Arnett 2016: 44-47

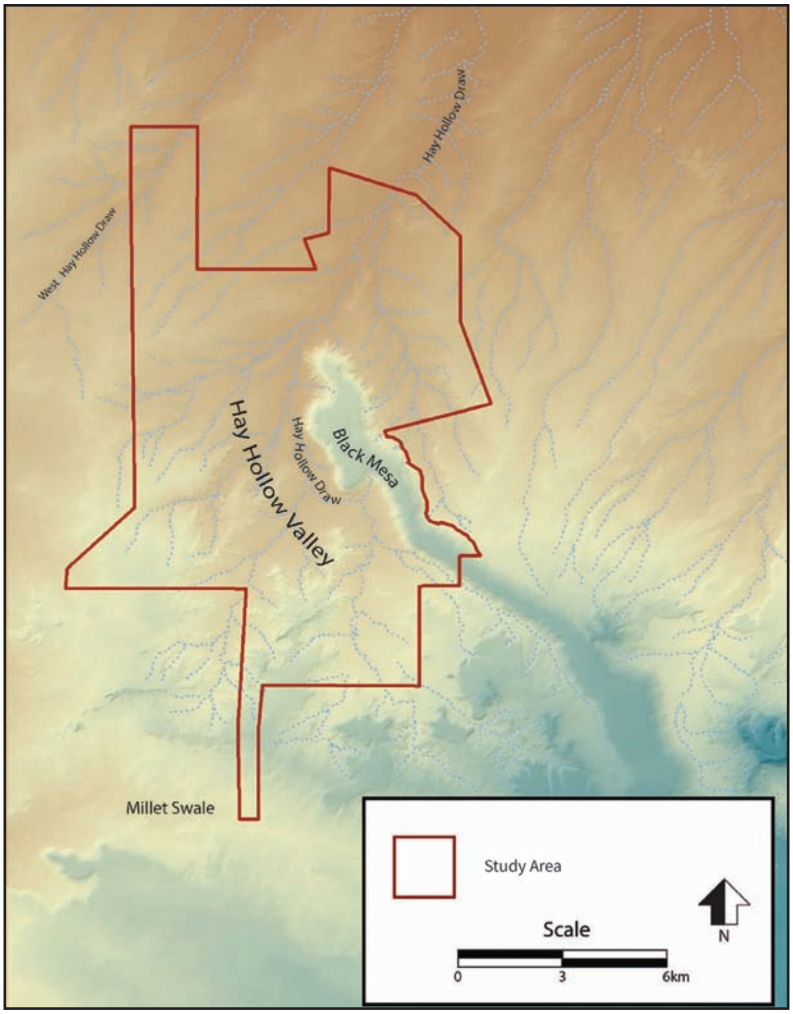

Figure 2. Elevation map with the study area shown in red.

for a detailed discussion). The site data collected by the members of the Expedition during the 1967-1968 New Survey of the Central Valley, East, and West Sample units constitutes the bulk of the dataset. In particular, the work undertaken by Ezra Zubrow (1971) proved the most valuable. According to Zubrow (1971:132-134), the New Survey consisted of a 100% sample inventory of the Central Valley Unit and 25% samples of the East Sample unit and West Sample unit. The sample units were surveyed by 5 to 10 people spaced no more than 5 meters apart maintaining parallel transects oriented with a compass. Zubrow (1971) included a total of 373 Ancestral Pueblo archaeological sites in Table 4 with site numbers ranging from NS 1 to 725. Of the 373 sites listed in Table 4, 287 were assigned date ranges by Paul S. Martin based on the analysis of a surface collected non-random sample of temporally diagnostic ceramic artifacts.

The potential for sampling bias and technical limitations of site recording methods of the 1950's and 1960's needed to be assessed by relocating a sample of archaeological sites previously recorded by members of the Expedition. Archaeological surveys took place between 2015 and 2016 on private land located within or near the Hay Hollow Valley. A total of 655 acres spread across 10 separate parcels were surveyed resulting in the relocation of 26 previously recorded sites, or just over 6% of the total number of previously documented sites. The surveys also resulted in the identification and documentation of 16 previously unrecorded sites located in areas peripheral to the Central Valley, East, and West Sample units comprising the New Survey (Table 2).

Archival Research. Archival research of the Paul S. Martin Field Museum Papers at The Field Museum in Chicago, Illinois provided additional survey and archaeological site data. The additional site data include hand drawn plan maps, National Science Foundation interim reports, artifact illustrations, survey maps with hand drawn notations, and archaeological site descriptions. Descriptions included in the survey cards from the 1959-1961 Longacre Reconnaissance Survey (Survey Cards, 1959-1961, Box 14, Paul Sydney Martin, Southwestern United States Archaeological Expeditions, Field Museum Papers, 1930-1977, Field Museum Papers, 1930-1977, Field Museum Library Archives. Chicago, Illinois) aided in the relocation of 7 previously documented sites (i.e., LS l06/ LS 155/Carter Ranch Pueblo, LS 208, 209, 212, 213, 230, and 232) south of the central part of the valley (Table 3). Two hand-drawn maps of the East Sample and West Sample units identifies the locations of additional non-randomly sampled survey areas (Map Case, Oversize 3, Paul Sydney Martin, Southwestern United States Archaeological Expeditions, Field Museum Papers, 1930-1977, Field Museum Library Archives. Chicago, Illinois). The unpublished descriptions of the County Road Site (1965 NSF Interim Report, Box 41, Paul Sydney Martin, Southwestern United States Archaeological Expeditions, Field Museum Papers, 1930-1977, Field Museum Library Archives. Chicago, Illinois) provide enough details concerning the artifact assemblage and architectural styles to compare with other early agricultural settlements within the valley and the southwest Cibola region as a whole. Archival documents also provide evidence of canal irrigation in the central part of the valley. Members of the Expedition identified seven main canals, several of which were test excavated and radiocarbon dated (Plog 1970 NSF Interim Report, Box 41, Paul Sydney Martin, Southwestern United States Archaeological Expeditions, Field Museum Papers, 1930-1977, Field Museum Papers, 1930-1977, Field Museum Library Archives. Chicago, Illinois). Finally, unpublished site plan maps (i.e., NS 421/Outov

Table 2. List of relocated and previously undocumented sites identified within each survey parcel.

Parcel	Acres	New Survey Sites	Longacre Sites	Previously Unrecorded Sites	Total	Site Numbers
1	15	4	0	0	4	NS 105, NS 107, NS 108, NS 109
2	80	2	1	3	6	Smiley Site (a.k.a. NS 663a), NS 663b, LS 152, AA_011, AA_012, AA_013
3	110	0	1	1	2	LS 230, AA_009
4	40	0	2	6	8	LS 212, LS 213, AA_008, AA_001, AA_002, AA_003, AA_004, AA_005
5	40	0	3	2	5	Carter Ranch Pueblo, LS 208, LS 209, AA_006, AA_007
6	80	5	0	0	5	Broken K Pueblo (NS 188), NS 186, NS 187
7	160	8	0	0	8	NS 199, NS 201 (HHV 201), NS 195, NS 171, NS 158, NS 28, NS 29, NS 185
8	10	0	0	1	1	Shannon Site
9	40	0	0	1	1	Saquaki
10	80	0	0	2	2	Turtle Rock_002, Turtle Rock_002
	655	**19**	**7**	**16**	**42**	

Table 3. Relocated Longacre Reconnaissance Survey Sites.

Site	Environmental Zone	Site Type	Architecture	Estimated/Actual Number of Structures by Type			
				Above Ground Masonry Rooms	Pit Structures	Slab Lined Surface Structures	Date
LS 152	Stair Step Mesas	Habitation	Cliff-dwelling	1	0	0	AD 1100-1200
LS 208	Floodplain	Habitation	Masonry Roomblock	3	0	0	AD 1100-1200
LS 209	Floodplain	Habitation	Masonry Roomblock	3	0	0	AD 1100-1200
LS 212	Floodplain	Habitation	Masonry Roomblock	10	0	0	AD 1150-1250
LS 213	Floodplain	Habitation	Masonry Roomblock	0	2	0	AD 850-950
LS 230	Floodplain	Habitation	Masonry Roomblock	3	0	0	AD 1150-1250
LS 232	Floodplain	Habitation	Masonry Roomblock	5	0	0	AD 1050-1150

Site, NS 512, NS 663a, NS 520, and NS 725) were used to verify and revise important site attribute information used in the dataset including observed and estimated counts of pit structures and above ground masonry architectural features (Figure 3).

Cultural Chronology. In order to further refine the dataset, the current study includes a revaluation of the chronometric data for the Hay Hollow Valley (see Arnett 2016:84-107 for a detailed discussion). A number of inter and intra-regional phase chronologies have been developed for the northern Southwest and the Cibola region (Haury 1985; Mills and Herr 1999; Kidder 1927; Lightfoot 1984; Plog 1974). Rather than attempting to awkwardly force the chronometric data into an existing phase chronology based on previous research (often in another part of the southwest Cibola region), or create yet another phase chronology, I assign general temporal divisions to sets of archaeological site data and, when applicable, defer to the Pecos Classification System developed by Kidder (1927).

An evaluation of absolute dates from excavated sites in the study area indicates that interpretations of chronometric data often failed to account for contextual information and built-in age disparity (Smiley 1985). A critical examination of absolute dates obtained from five sites using radiocarbon and tree-ring dating methods resulted in the modification of the temporal ranges of occupation. Sites include the Hay Hollow Site (Berry 1982; Fritz 1974; Smiley 1985), County Road (Martin 1965 NSF Interim Report, Box 41, PSM, SUSAE, FMP, 1930-1977, FMLA. Chicago, Illinois), Carter Ranch Pueblo (Bannister et al. 1966:58; Herr 2001:54-58; Longacre 1970), Broken K Pueblo (Hill 1970; Martin et al. 1967b), and the Joint Site (Hansen and Schiffer 1975; Wilcox 1975). For most of the sites the modifications were slight but significant, nonetheless. Errors made in the reporting and interpretation of chronometric data only make sorting out the temporal affiliations of sites in the Hay Hollow Valley more difficult. However, despite

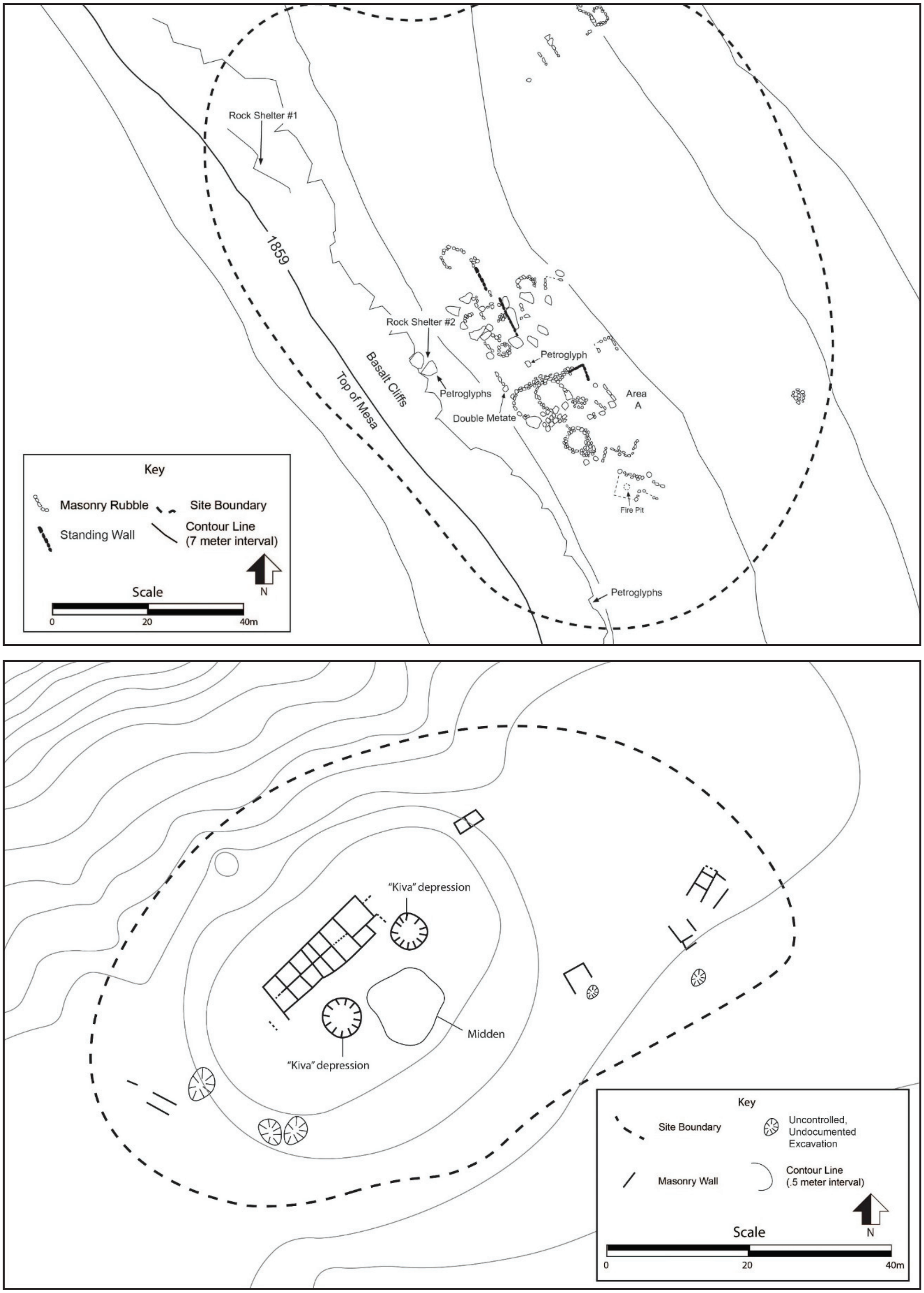

Figure 3. Plan map of NS 421/Outov Site (top) and NS 520 (bottom), redrawn from hand-drawn plan maps, Field Museum Library Archives.

Table 4. Differential distribution of limited activity sites through time.

	Floodplain	Floodplain Margin	Ridges	Stair Step Mesas	Slope of Black Mesa	Top of Black Mesa	Total	Percent of Total
5500-3500 BP			1				1	1%
A.D. 100-1200		1					1	1%
200-600	1	1	1				3	2%
400-700	4	3		1	2		10	5%
600-800	6	5					11	6%
700-1000	21	13	7	5	1	2	49	26%
850-1050			1				1	1%
900-1150	31	16	11	8	21	8	95	51%
1000-1300			1				1	1%
1050-1300	5	1		3		2	11	6%
1100-1450			1		3	1	5	3%
Total	**68**	**40**	**23**	**17**	**27**	**13**	**188**	**100%**
Pecent of Total	**36%**	**21%**	**12%**	**9%**	**14%**	**7%**	**100%**	

* includes 7 canal segments

** includes separate temporal components at Rockin'D Ranch

the paucity of chronometric data available, ceramic artifacts provide important temporal markers for relatively dating sites. An analysis of ceramic artifacts from Carter Ranch Pueblo and the Joint Site indicate the need for only slight modifications to the ceramic chronology developed in other parts of the southwest Cibola region (Hays-Gilpin and Van Hartesveldt 1998; Mills 1999).

ANALYSIS

Calculations in ArcGIS demonstrate that approximately 30% of the total study area (30 out of 99 sq km) has been surveyed (Figure 4). Thus, the total number of square kilometers surveyed relative to the size of the study area indicates that the dataset adequately represents the population. Approximately 97% of the top of Black Mesa and 85% of the slopes of Black Mesa within the study area were surveyed by members of the Expedition. A total of 45% of the floodplain and 29% of the floodplain margins were also surveyed. The smallest surveyed portions of any environmental zone within the study area include the stair step mesas with only 12.4% surveyed and ridges with about 18% surveyed. Sites located within the surveyed portions of the environmental zones were first divided into two main analytical categories: limited activity sites and settlements.

Limited Activity Sites. A total of 188 sites or 44% of the dataset consists of relatively dated limited activity sites (Table 4). The majority of limited activity sites were found within the floodplain and floodplain margins. In contrast, only 14% of all dated limited activity sites were found in the stair step mesas environmental zone, and only 12% were found in the ridges environmental zone. The zones with the lowest percentage of limited activity sites include the slopes of Black Mesa and the top of Black Mesa.

The distribution of limited activity sites varies across the study area over time. Just over half of all limited activity sites date between about AD 900 and 1150 and of those, the majority were found within the floodplain. Between about AD 400 and 900 most limited activity sites were located in the floodplain and floodplain margins. Beginning around AD 900, the number of limited activity sites increase in the stair step mesas, slopes of Black Mesa, and top of Black Mesa environmental zones while the number decreases in the floodplain and floodplain margins. By about AD 1200 limited activity sites appear to have been equally distributed between the top of Black Mesa, the slopes of Black Mesa, stair step mesas, and the floodplain. Limited activity sites in the Hay Hollow Valley disappear from the archaeological record around AD 1450.

Although at least seven different types of previously recorded or newly-recorded limited activity sites were identified during the current study, arguably the most significant include water control features (Figure 5). The majority of the water control features appear to have functioned as canals or ditches used to divert water from Hay Hollow Draw or away from intermittent streams (Plog 1970, NSF Interim Report, Box 41, PSM, SUSAE, FMP, 1930-1977, FMLA, Chicago, Illinois). Charcoal samples were collected from the lower fill of exposed profiles of 3 canals (Canal A-1, Canal C-2, and Canal C-3). Check dams were found in two locations within the floodplain: one near Broken K Pueblo (ca. AD 1150-1280, Martin 1967b), and another near LS 230

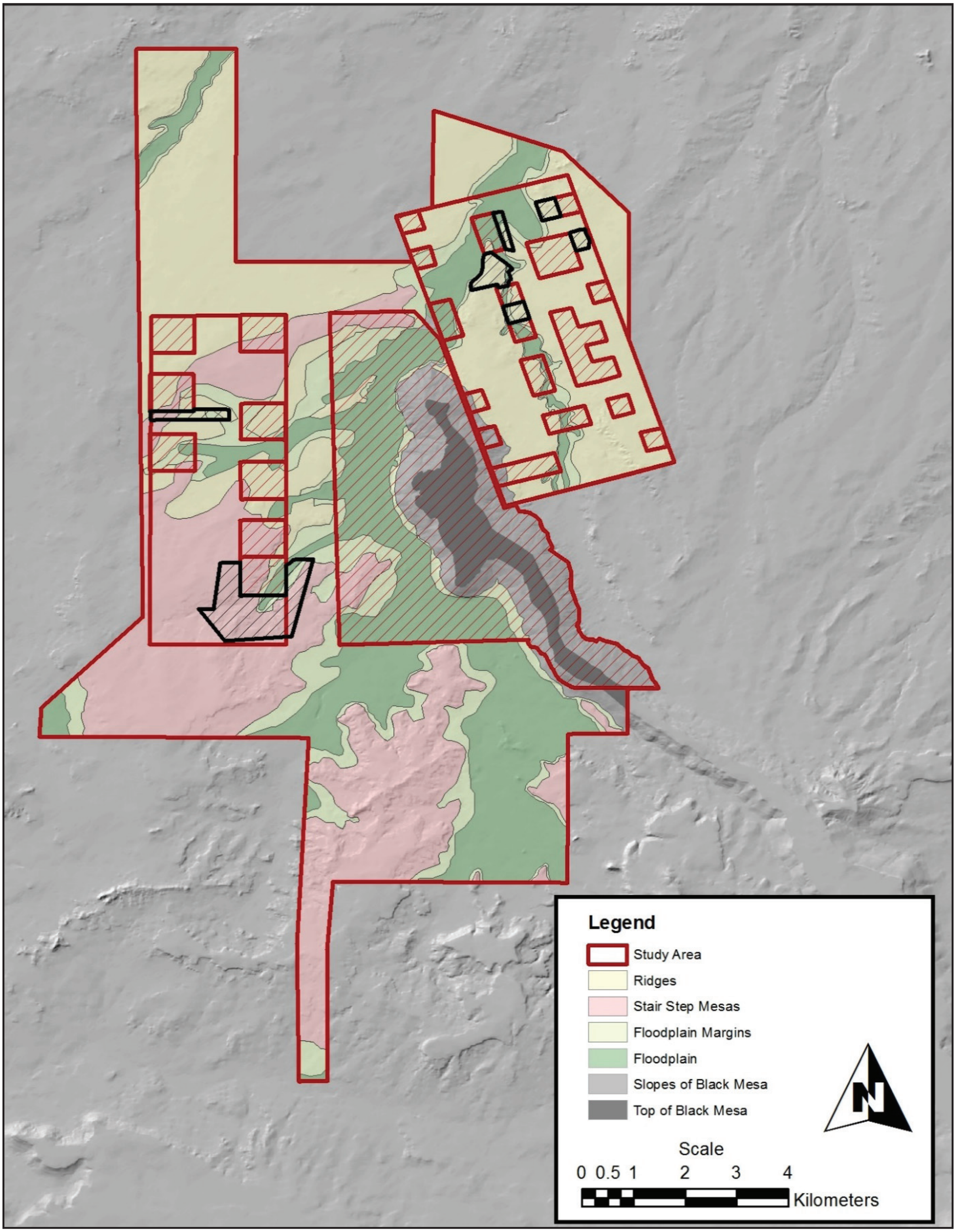

Figure 4. Intersection of West, Central, and East Sample Areas with environmental zones within the study area. Black-hatched polygons indicate additional non-randomly sampled survey areas identified from hand drawn maps, Field Museum Library Archives.

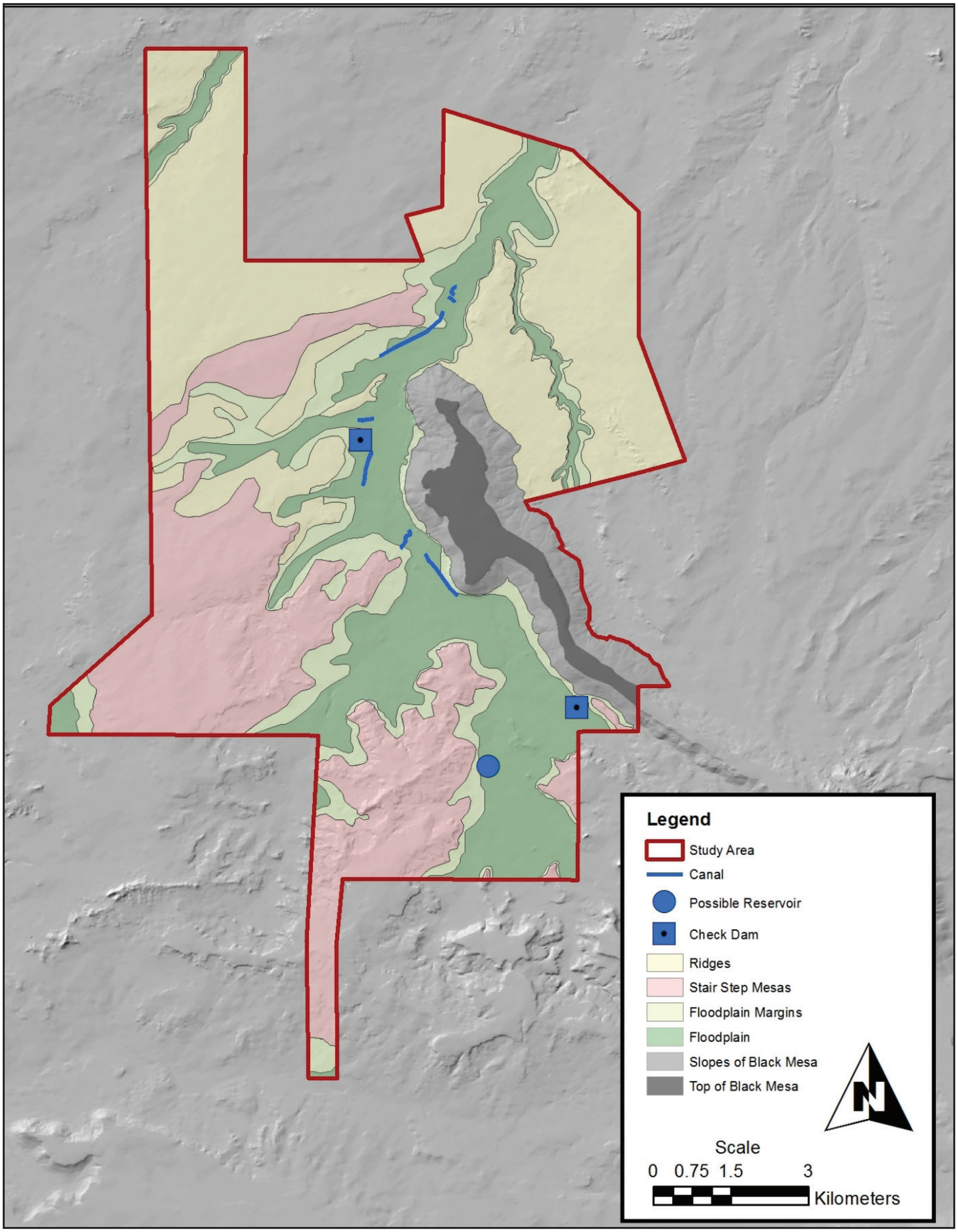

Figure 5. Locations of water control features in the floodplain environmental zone.

and LS 232 (Survey Cards, 1959-1961, Box 14, PSM, SUSAE, FMP, 1930-1977, FMLA. Chicago, Illinois), two habitation sites relatively dated to AD 1150-1250 and AD 1050-1150. Both features consist of linear alignments of sandstone cobbles and boulders within or immediately adjacent to erosion channels. Finally, one possible reservoir originally identified by Longacre in 1960 sits within the Carter Ranch Pueblo site boundary just north and east of the great kiva (Survey Cards, 1959-1961, Box 14, PSM, SUSAE, FMP, 1930-1977, FMLA. Chicago, Illinois). The feature consists of a shallow, circular shaped earthen depression that measures approximately 12 meters in diameter and covers an area of about 140 square meters. Despite the paucity of chronometric data, the majority of water control features found in the Hay Hollow Valley appear to date sometime between AD 1100 and AD 1450.

Settlements. Similar to limited activity sites, the distribution of the number of habitation sites, or settlements, varies across the study area over time (Table 5). Figure 6 shows a chronological array of the distribution of settlements through time for each environmental zone. The array indicates the earliest settlements in the study area were located within a variety of different environments that include the floodplain, floodplain margins, ridges, and stair step mesas (Figure 7). Between about AD 100 and 550 to 600, settlements were concentrated on the top and slopes of Black Mesa, along the tops of ridges, and on mesa tops. After AD 550 the number of settlements in the floodplain increases dramatically, followed by an increase in the number of settlements along the margins of the floodplain, ridge tops, and the slopes of Black Mesa by about AD 900 to 950. With the exception of the top of Black Mesa, between AD 950 and 1150 the number of settlements across the study area increases sharply with the largest increase occurring within the floodplain. By about AD 1150 the number of settlements in the floodplain, and throughout most of the study area, decreases. At about the same time the number of settlements in the stair step mesa environmental zone begins to increase. Between AD 1200 and 1280 the number of sites decreases while the number of rooms per site increases. The general decrease in the total number of settlements culminates with the apparent depopulation of the Hay Hollow Valley by about AD 1325.

Analysis of Room Counts. In addition to analyzing the distribution of limited activity sites and settlements over time across the study area, actual room counts or room estimates included as part of the site attribute data were used to evaluate changes in the sizes of settlements. A total of 1,172 rooms were identified at habitation sites either by estimating room counts based on architectural remains (e.g., New Survey) or as a result of excavations by members of the Expedition (e.g., Carter Ranch Pueblo). Sites with habitation rooms were divided into 13 one-hundred-year intervals beginning at AD 100 and ending at AD 1400. In order to estimate the total number of habitation rooms for any 100-year time period, the estimated or actual number of rooms needed to be distributed across the entire length of occupation for each site. The estimated or actual length of occupation of habitation sites or settlements based on relative or absolute dating of sites in the dataset varied from less than 100 years to 400 years. Based on the assumption that not all domestic rooms at any habitation site in the dataset were used simultaneously, the number of rooms at sites with lengths of occupations greater than 100 years was distributed throughout the temporal span using the growth curve described by Plog (1974:91).

Plog (1974) explored patterns of demographic change in the Hay Hollow Valley using a growth curve developed by Hill (1965:203, cited in Plog 1974) for Broken K Pueblo. Concluding that “the maximum number of rooms actually occupied at one time on a site is about 78% of the total number of rooms on the site,” Plog (1974:91) divided the temporal ranges of sites in the Hay Hollow Valley into 50-year intervals and assumed a higher probability that a site was occupied “at the midpoint than at either end of the span.” Plog also assumed that half the maximum number of rooms were occupied during earlier or later periods. For example, borrowing from Plog (1974:91), a site with 100 rooms dating between AD 900 and 1100 would have a maximum number of 78 occupied rooms between AD 950 and 1050. Between AD 900 and 950, and between A. D. 1050 and 1100, the number of occupied rooms would be half of 78 or 39.

Because Plog (1974) divided sites into 50-year intervals rather than 100-year intervals, modifications to the growth curve included further reducing the number of rooms by half for sites with occupations beginning and ending in the middle of different periods of time.

For example, Site NS 10 consists of five habitations dating between AD 950 and 1150. Between AD 900 and 1000, and 1100 to 1200, the number of rooms was reduced from 1.95 (half of 3.7 or .78% of 5) to .97 in order to account for the likelihood that the occupation of NS 10 did not begin until around AD 950, during the last half of the AD 900 to 1000 interval, and ended around AD 1150.

Another modification to the growth curve included dividing the total number of rooms at a site with an estimated or actual range of occupation spanning two centuries. In this situation the rooms were divided equally between the two 100-year time periods. Finally, rooms at settlements with occupations at the beginning of one time period and ending in the middle of another time period were divided into 50-year increments and adjusted based on the growth curve. The adjusted room totals for each 50-year increment were then combined within each 100-year interval. Estimates for the total number of rooms for each 100-year period between

Table 5. Differential distribution of the number of settlements across the study area over time.

Floodplain		Floodplain Margin		Ridges		Stair Step Mesas		Slope of Black Mesa		Top of Black Mesa	
Date Ranges	Habitation Sites	Date Ranges	Habitation Sites	Date Ranges	Habitation Sites	Date Ranges	Habitation Sites	Date Ranges	Habitation Sites	Date Ranges	Habitation Sites
100-350	1	100-300	1	100-350	1	100-500	1	400-700	1	420-540	1
500-700	4	200-400	1	200-400	1	800-1100	1	400-800	1	300-600	1
500-800	1	700-800	1	200-700	1	900-1000	1	700-900	1		
550-750	1	800-950	1	650-850	1	1100-1200	1	900-1000	2		
600-700	1	900-1000	2	700-1000	1	1100-1250	1	950-1150	5		
600-800	3	925-975	1	700-800	1	1125-1225	1	1000-1150	1		
650-750	1	950-1050	1	700-950	1	1150-1250	1	1000-1250	1		
650-850	1	950-1150	4	800-900	2	1200-1275	1				
690-825	1	1000-1050	1	900-1050	1	1225-1275	1				
700-1100 (NS 11a,b,c)	1	1000-1100	2	950-1050	1						
700-900	4	1100-1200	2	950-1150	1						
750-850	1	1150-1250	3	950-1200	2						
750-950	2	1175-1280	1	1000-1100	1						
850-1000	1	1200-1275	1	1000-1150	4						
850-950	4			1000-1200	1						
900-1000	2			1050-1150	1						
900-1050	1			1100-1200	1						
900-1100	3			1100-1300	1						
950-1050	5			1150-1250	2						
950-1100	1			1200-1300	1						
950-1150	13			1275-1325	1						
1000-1050	2										
1000-1100	2										
1000-1150	3										
1050-1100	1										
1050-1150	2										
1050-1200	2										
1050-1250	1										
1100-1200	6										
1100-1300	1										
1125-1225	1										
1150-1250	1										
Total	**74**		**22**		**27**		**9**		**12**		**2**

AD 100 and 1400 were then adjusted based on Plog (1975:98). Table 6 shows the room estimates for each 100-year time period using the growth curve modified from Plog (1975).

In many cases the result of the distribution of the total number of rooms created fractions of rooms occupied within 100-year intervals. Rather than indicating that only portions of rooms were occupied, the distributions were created in order to divide the occupations of all sites in the dataset as consistently and evenly as possible based on the available data. Because the data consists of an aggregate of estimated and actual room totals for each site spanning a period of about 1,225 years, the division of rooms between time periods us-

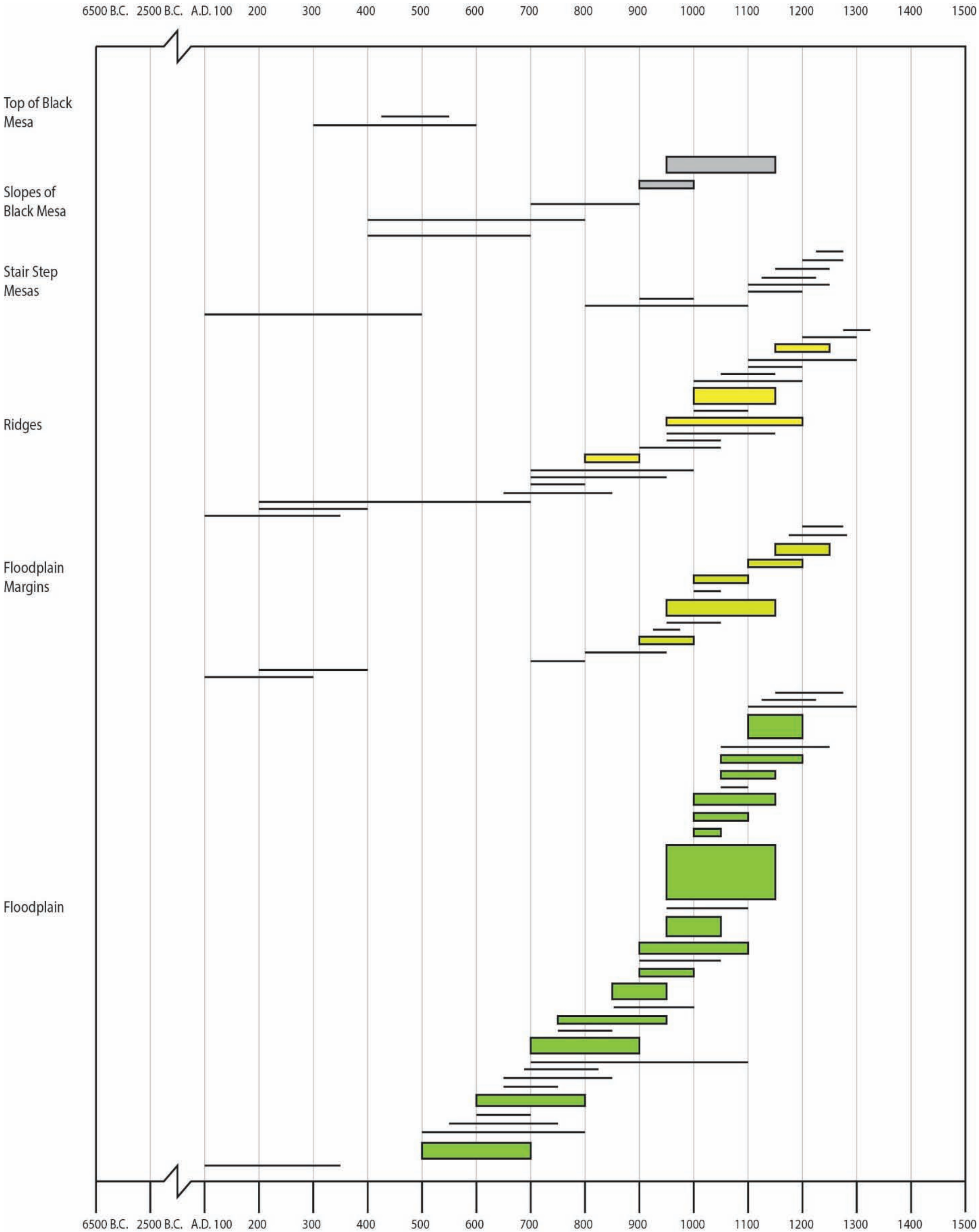

Figure 6. Chronological array of the differential distribution of habitation sites across each of the environmental zones. Lines represent individual sites while the thickness of the bars represent the number of sites falling within specific temporal ranges.

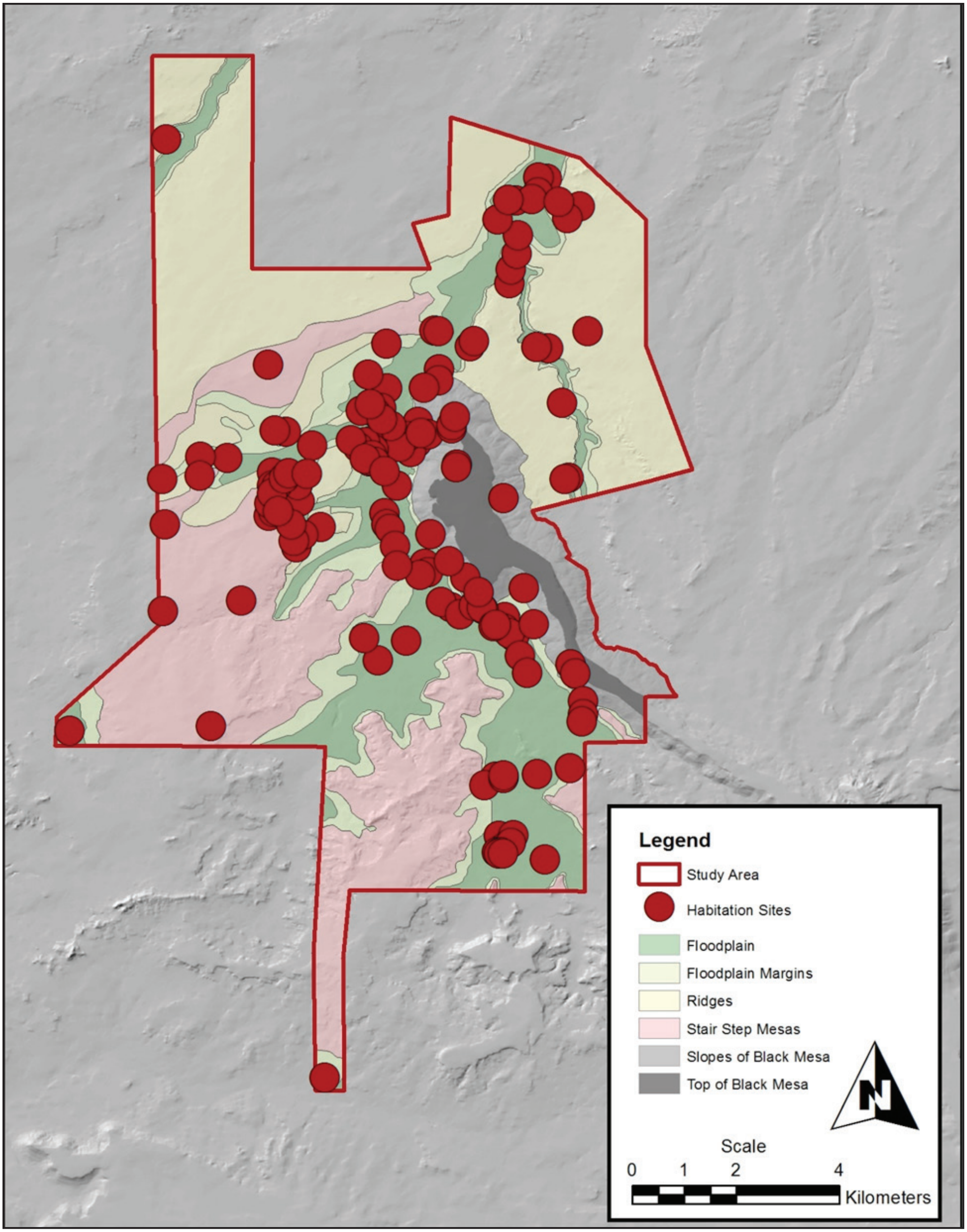

Figure 7. Distribution of all documented habitation sites within the study area.

Table 6. Room estimates per 100-year interval across the study area.

Years A. D.	Floodplain	Floodplain Margin	Ridges	Stair Step Mesas	Slope of Black Mesa	Top of Black Mesa	Total*
100-200	0	2	0	15.6	0	0	17.6
200-300	5.5	6.5	7.18	31.2	0	0	50.38
300-400	3.5	4.5	11.86	31.2	0	14.04	65.1
400-500	0	0	9.36	15.6	0.39	50.74	76.09
500-600	22.9	0	4.68	0	1.28	25.37	54.23
600-700	42.52	0	4.87	0	0.89	0	48.28
700-800	40.9	2	35.98	0	2	0	80.88
800-900	31.07	7.02	34.83	3.12	3.59	0	79.63
900-1000	37.17	19.09	11.60	5.43	3.88	0	77.16
1000-1100	69.22	15.14	23.47	2.34	6.43	0	116.59
1100-1200	91.80	42.89	26.95	22.19	1.64	0	185.47
1200-1300	4.13	65.74	53.1	34.55	0.11	0	157.63
1300-1400	0	0	23.6	0	0	0	23.6
Total	348.70	164.87	247.47	161.23	20.21	90.15	1032.64

*Based on Plog (1975:98)

ing a modified version of the growth curve described by Plog (1975:97-98) should result in a reasonably accurate distribution of rooms over time. Also, the total number of estimated rooms using the growth curve exceeds the total number of rooms within several 100-year intervals because not all rooms at a settlement were constructed, occupied, or abandoned at exactly the same time.

The distribution of documented Ancestral Pueblo habitation rooms varies between environmental zones over time (Figure 8). Beginning around AD 100, the majority of rooms were located in the stair step mesa environmental zone and were concentrated within one large settlement (NS 663a/The Smiley Site). With an estimated 40 pit structures and an estimated range of occupation falling sometime between AD 100 and 500 based on early brownware ceramics, grayware ceramics, and similarities in architectural features associated with Sivu'ovi in Petrified Forest (Burton 1991), the Smiley Site appears to have been one of the largest settlements in the study area for any time period. By about AD 400 or 450, the majority of the population appears to have been concentrated within the only settlements found on the top of Black Mesa (Rogge et al. 2015). Beginning around AD 500 the number of rooms within the floodplain increases while the number of rooms on mesa tops sharply declines. Between about AD 500 and 900 the majority of rooms at Ancestral Pueblo settlements were found within the floodplain and on ridge tops. The period between AD 900 and 1200 marks the highest concentration of rooms within the floodplain and floodplain margins. The period with the largest number of rooms in the study area falls between AD 1100 and 1200. After AD 1200, the number of rooms in the floodplain decreases sharply while the number of rooms within the ridges, floodplain margins, and stair step mesas increases. By AD 1300 only one settlement, NS 201, a 76-room pueblo located on a ridge top overlooking the floodplain, was occupied.

Settlement Demographics. Because Plog's (1975) demographic reconstruction of the Hay Hollow Valley incorporated much of the same site data that included estimates of the total number of rooms using a growth curve model as a measure of population, a comparison of the two distributions of rooms over time seems warranted. Previous research resulted in a reconstructed pattern of demographic change in the Hay Hollow Valley using the data from the surveys conducted by members of the Expedition. Figure 9 shows a modified version of the same graph with the results of the present study in red. If room counts can be used to infer population size, then the data show a more gradual increase in population between AD 300 and 500, and a sharper increase beginning around AD 950.

Mean Center and Standard Distance Analysis. GIS analysis of the distribution of habitation sites in the dataset included calculations of the mean geographic center and the standard distance of which habitation sites are concentrated or dispersed around the mean geographic center. Based on the observed changes in settlement, habitation sites were divided into six partially overlapping time periods of varying length. The mean center and standard distance were then calculated using ArcGIS for each time period using room counts as a weighted field to take into account assumed anthropological differences between settlements of different sizes, and to indicate the differences between larger settlements with typically longer spans of occupation and evidence of public and ritual space over smaller, typically shorter-lived settlements when considering changes in settlement and land use over time.

The determination of the weighted mean center and weighted standard distance indicate patterns of settlement that cross cut environmental zones in the study area. The weighted mean geographic center of settlements remains fairly constant between about AD 100 and 1150. During that time the weighted mean geographic center lies within 1 kilometer of a confluence of several large drainages including Hay Hollow Draw

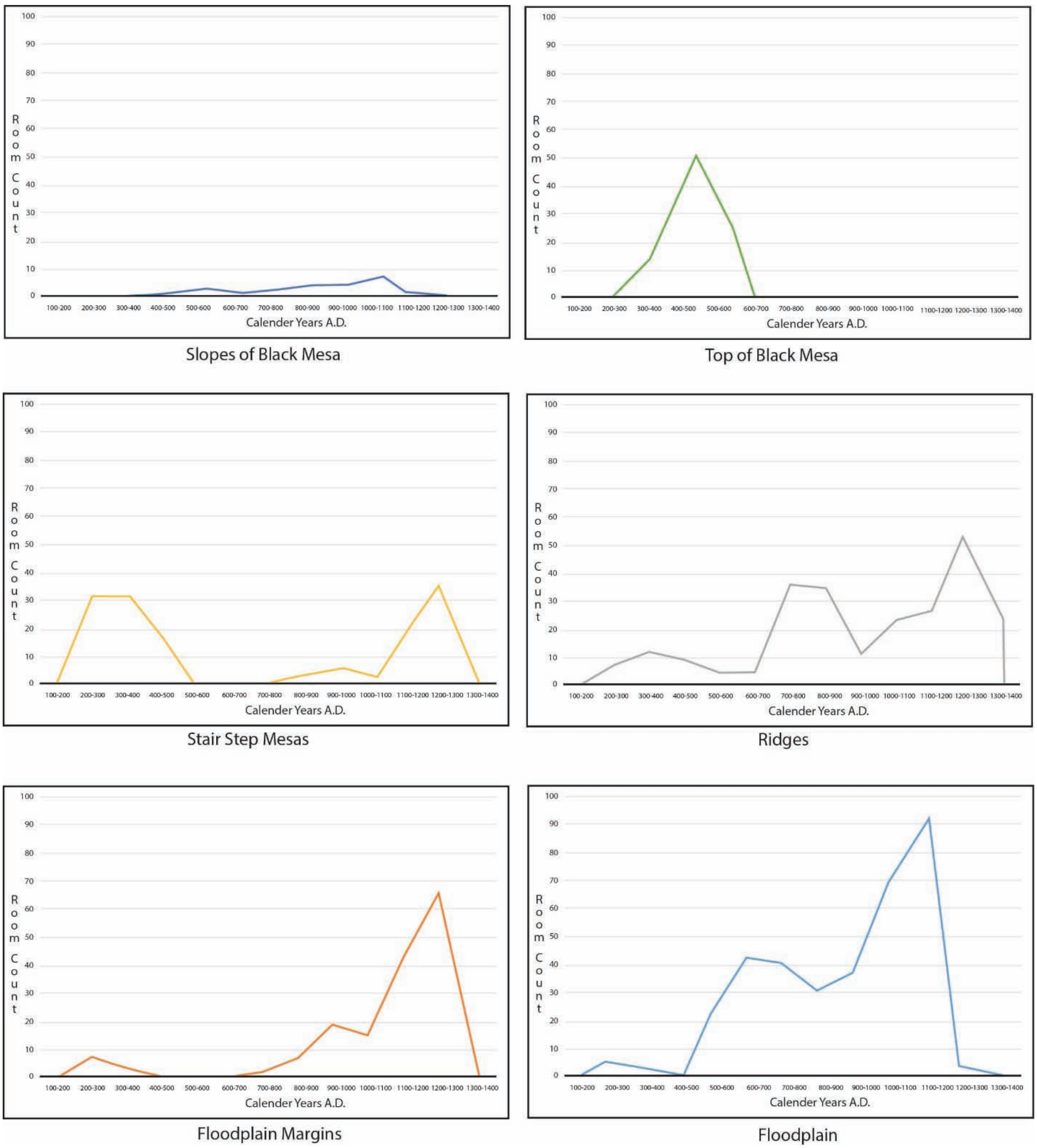

Figure 8. Differential distribution of all documented Ancestral Pueblo habitation rooms across each of the environmental zones included within the study area over time.

located near the central portion of the valley. The drainages channel water from large portions of the floodplains and mesa tops farther to the south, southwest, and southeast. The proximity of the weighted mean center of all settlements dating between AD 100 and 1150 indicates the importance of the confluence and the surrounding floodplain (Figure 10). Curiously, between about AD 1100 and 1200 the mean geographic center of all settlements shifts south from the central portion of the valley.

Changes in the weighted standard distance of settlements from the mean geographic center also indicate changes in settlement patterns over time (Figure 11). Between AD 100 and 550 or 600, the weighted standard distance consists of a relatively small area surrounding the central portion of the valley. After AD 550 the standard distance increases and remains constant until about AD 1100. At that time the standard distance increases, reflecting changes in settlement that include the floodplains in the southern portion of the study area as well as stair step mesas and ridges to the southwest, west, and north. Between AD 1200 and 1280 the weighted standard distance decreases in size and shifts back to the north. After AD 1275 only one documented settlement remains in the valley. Thus, the weighted standard distance from the geographic mean center of all settlements falls to zero.

The results of the GIS analysis help confirm the patterns of settlement and land use first identified using exploratory data analysis and the analysis of the distribution of room counts across the study area over time using the growth curve model. The changes in weighted standard distance demonstrate a gradual increase in the number of settlements, and presumably population, in the study area and an expansion of settlement away from the mean geographic center (i.e., the confluence near the center of the valley) between about AD 100 to 1150. Sometime between AD 1100 and 1200 the population peaks and appears to have expanded to the maximum geographic extent across the study area. Sometime shortly before or after AD 1200 the number of settlements, the number of habitation rooms, and the distance from the mean geographic center rapidly decreases. Afterward, beginning in the late 1200s, the

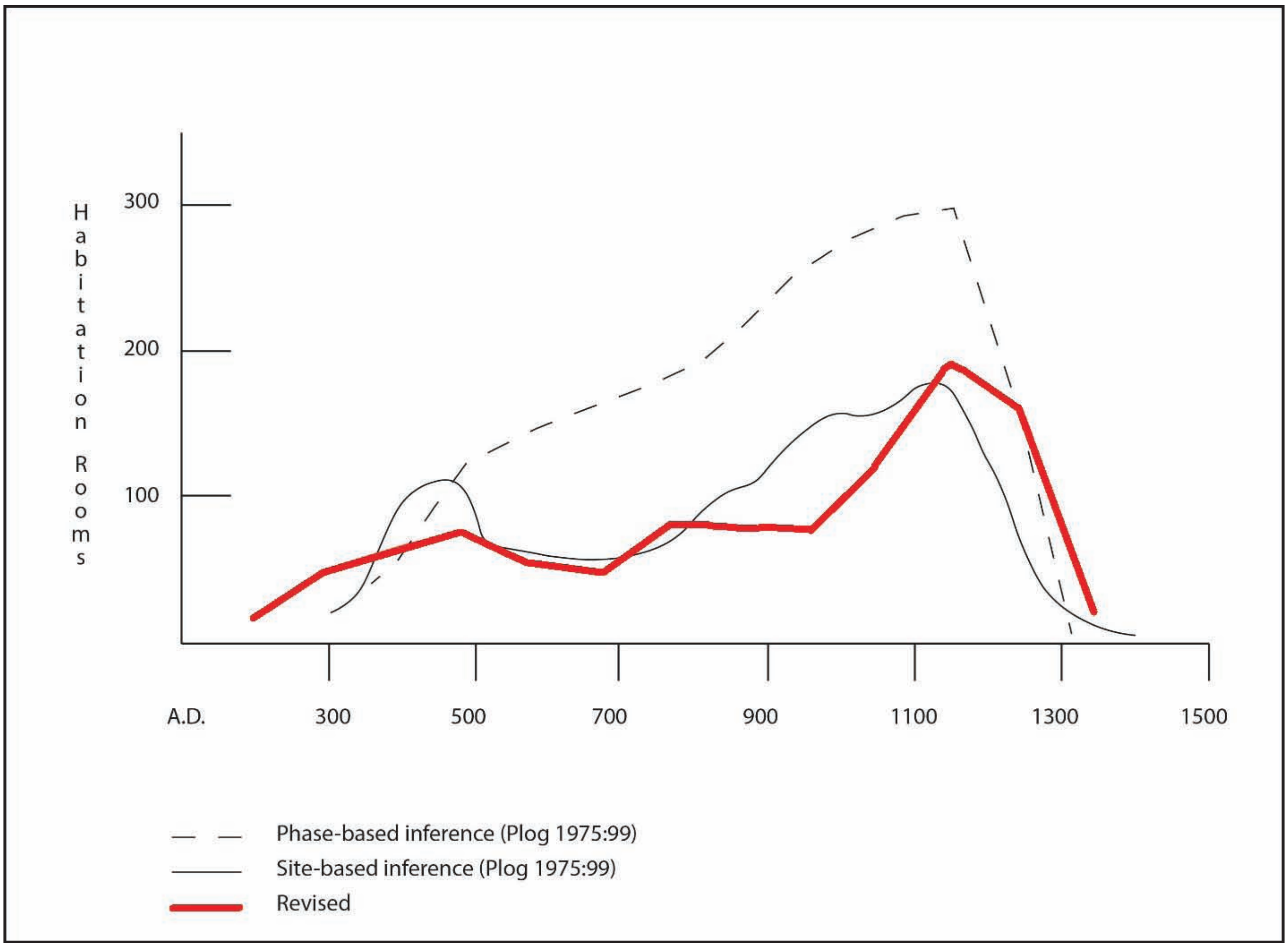

Figure 9. Changes in habitation rooms over time in the Hay Hollow Valley with a revised curve based on the present study in red (adapted from Plog 1975:99, Figure 1).

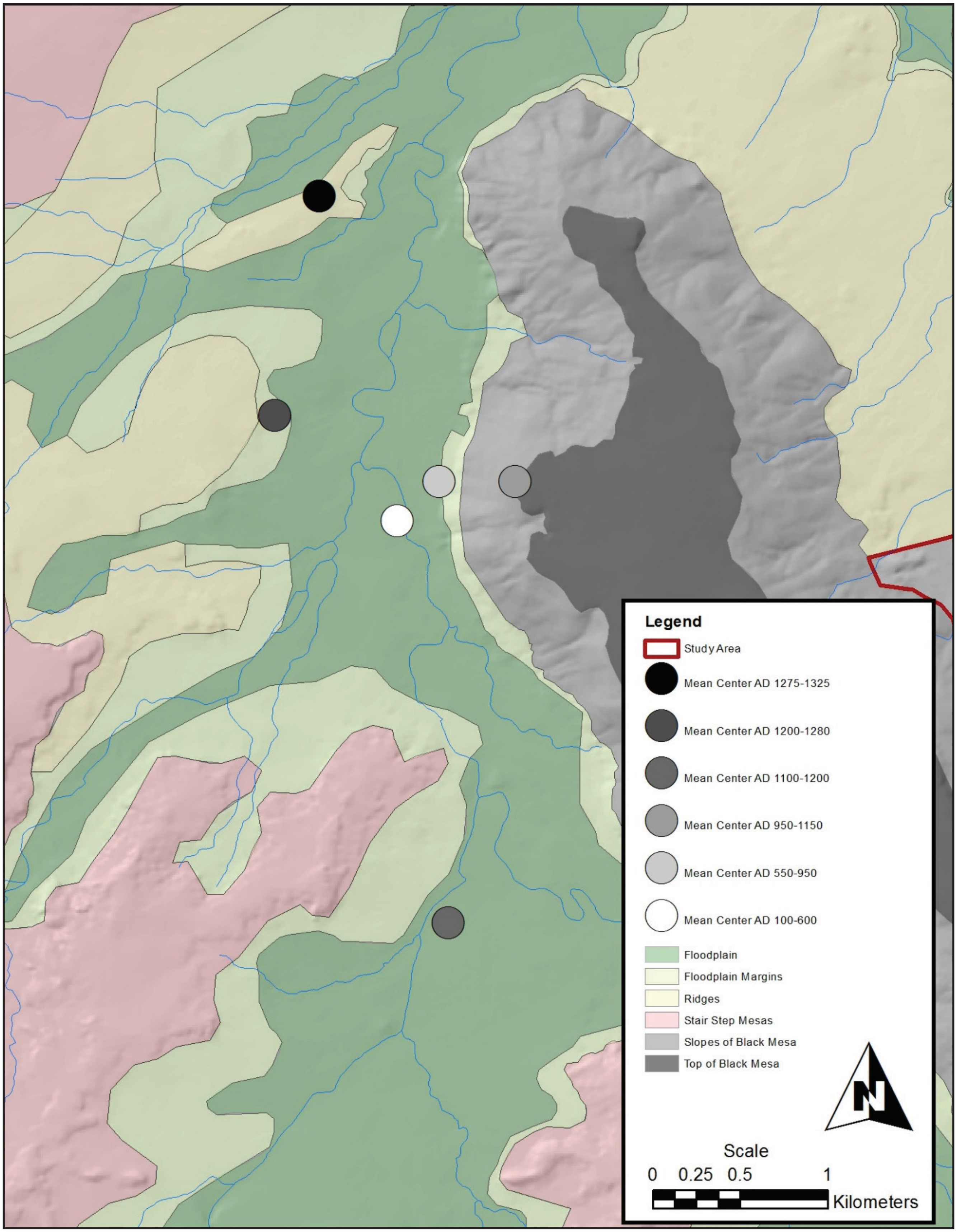

Figure 10. Changes in the weighted mean geographic center of settlements over time.

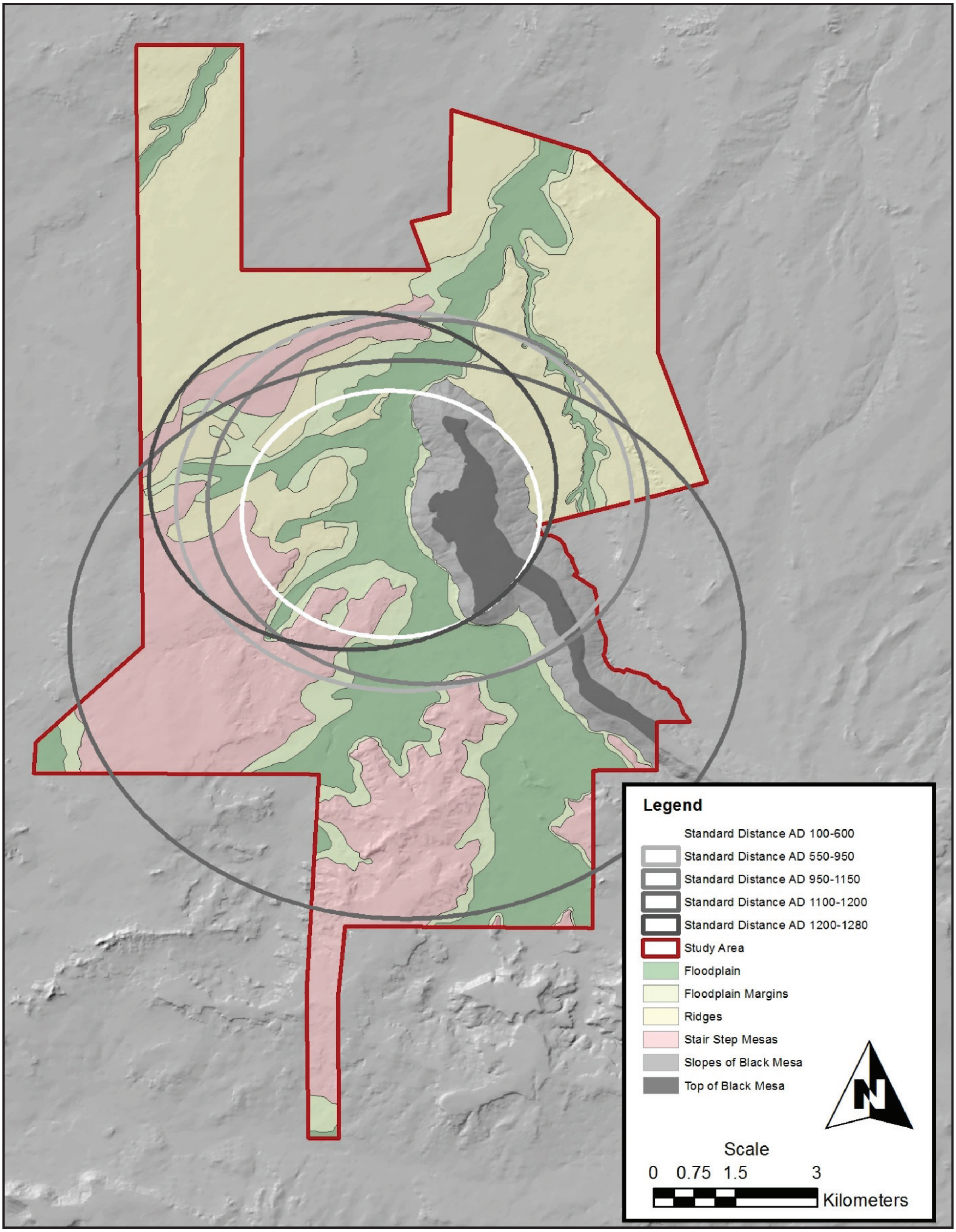

Figure 11. Changes in the weighted standard distance of settlements from the weighted mean geographic center over time.

remaining population becomes concentrated into a single large, but relatively short-lived settlement (i.e., NS 201) before the study area is depopulated.

DISCUSSION

Analysis of the archaeological site data points to an area of the southwest Cibola region with enough natural resources to support Ancestral Pueblo farmers from about AD 100 to AD 1325. Between about AD 400 and 700, limited activity sites increase in number and are fairly evenly distributed among the floodplain and the floodplain margins' environmental zones. The density of limited activity sites on or near the floodplains suggests decreasing mobility as a result of increasing dependence on floodwater farming following the introduction of maize to the area sometime around AD 100. After AD 400 the number of limited activity sites increase over time and reach a peak between AD 900 and 1150. Few limited activity sites were situated on the slopes of Black Mesa prior to about AD 900. Between AD 900 and 1150, the number increases dramatically and even exceeds the number of sites located along the margins of the floodplain. Areas on the slopes of Black Mesa show evidence of cleared boulders forming borders around agricultural fields (Fred Plog, 1970 NSF Interim Report, Box 41, PSM, SUSAE, FMP, 1930-1977, FMLA, Chicago, Illinois). The high density of limited activity sites between AD 900 and 1150 in the floodplain, floodplain margins, and the slopes of Black Mesa indicate increased sedentism resulting from agricultural intensification.

Despite the paucity of data, cobs of maize, pithouse architecture, ground stone, and ceramic artifacts found in association with Archaic projectile points at early agricultural settlements dating between AD 100 and 550 to 600 indicate a gradual transition from a highly mobile hunting and foraging subsistence strategy to an economy based on farming. During that time, individuals and nuclear or extended families may have been experimenting with different combinations of hunting, foraging, and farming that led to settlement in a variety of different environmental zones, fluctuations in the duration of settlement, and changes in community organization. The largest sites dating between AD 100 and 600 lie on the tops of mesas overlooking the floodplain near the center of the valley. Large sites include the Smiley Site (NS 663a), the Connie Site (NS 225), and NS 243 (Figure 12). Although more research is needed, pithouse settlements with large, centrally-located pit structures dating between AD 100 and 550 to 600 in the Hay Hollow Valley may indicate the establishment of coalescent communities centuries prior to the formation of large agricultural settlements in the Mesa Verde area like Site 13 on Alkali Ridge (Brew 1946) and McPhee Village (Wilshusen and Van Dyke 2006:216-219) preceding the development of the Chaco regional system (Lekson 2006).

Analysis of the site attribute data across environmental zones indicates that, between AD 700 and 1350, changes in social organization led to increasing social complexity based on the appearance of integrative architectural features such as great kivas (i.e., Carter Ranch Pueblo) and plazas (i.e., Broken K Pueblo, Saquaki Pueblo, and NS 105, Figure 13), shifts in settlement and land use resulting from population pressure, and technological innovations intended to more efficiently exploit natural resources. Although Herr (2001) correlates great kiva sites in the southwest Cibola region with migration into the area from other parts of the plateau around AD 1050, analysis of the habitation site data in the Hay Hollow Valley shows a sharp increase in the total estimated number of rooms beginning at least a century earlier. Based on the variety of architectural styles appearing at agricultural settlements (ca. AD 600 to 950), Gilbert and Miller (2016:4) suggest that people moved to the area from other parts of the southwest including the Puerco and middle Little Colorado River valleys, the Mogollon Rim, and parts of the upper Sonoran Desert. Thus, settlements with great kivas like Carter Ranch Pueblo may have served integrative functions for an already increasing number of people intensively farming the floodplains. Together the ritual architecture, large midden, and large (>1 meter in length) slab-lined roasting pits located within a second partially-enclosed plaza wall indicate the site, like similar settlements located closer to Chaco Canyon, may have served as a ritual focal point for a dispersed community (Kantner and Mahoney 2000; Kantner and Kintigh 2006).

Like other large masonry pueblos with similar architectural features including great kivas and plaza walls found further to the north and east, Carter Ranch Pueblo may have also functioned as a means for redistributing agricultural surpluses (Judge and Cordell 2006:196). Canal irrigation suggests that one of the primary adaptive strategies coincident with agricultural intensification and a rapid increase in population beginning around AD 950 included technological innovations designed to control the flow of water through the valley. Totaling over five km in combined length, the construction of canals in the floodplain after about AD 1100 demonstrates a level of social organization above the nuclear or even extended family. Construction and regular maintenance of irrigation canals would have required a significant investment in labor that may have incorporated farmers located throughout the valley. Concurrent with canal irrigation, shifts in settlement away from the floodplain beginning around AD 1100 suggests farmers may have experimented with different farming techniques in other parts of the valley. Finally, the significant decrease in the number of settlements and estimated number of rooms per 100-year period beginning around AD 1200, followed by the depopulation of the Hay Hollow Valley around AD 1325, represents one of the most significant changes in settlement and land use patterns observable in the archaeological record.

CONCLUSION

Preliminary analysis of archaeological site data compiled from multiple sources resulted in the identification of demonstrable changes in Ancestral Pueblo settlement and land use, population increase, and the development of technological innovations relating to agricultural intensification over time in the Hay Hollow Valley between AD 100 and 1325. Although more research is needed, such changes may have been motivated by fundamental transformations in subsistence strategies and settlement. The limits of the available natural resources in the Hay Hollow Valley may have imposed constraints on the Ancestral Pueblo population and in measurable ways helped inform decisions relating to the exploitation and control of finite natural resources including arable land and access to perennial water. The abundance, quality, and comparability of the archaeological data serves as a powerful tool in the evaluation of the differences in site density and the different types of sites present in the various environmental zones comprising the study area.

Rather than competition, the results of the analysis suggest that interdependence and adaptability may have been driving changes in social organization between about AD 100 and 1325. Integrative architectural features in the form of centrally-located, oversized pit structures were found at large early agricultural settlements and plazas at later sites including Broken K Pueblo, NS 211, and Saquaki Pueblo. Integrative architectural features including large, centrally-located pit structures, great kivas, and plazas may represent systems of agricultural surplus redistribution and the reification of social and economic ties through ritual and other forms of religious expression.

The present study adds to the growing body of research in the southwest Cibola region in order to answer important questions that have far reaching implications beyond mere academic curiosity. How did past human social groups negotiate access to arable land, water, and other finite natural resources critical for survival? Changes in social organization relating to settlement and land use in the Hay Hollow Valley indicate that, prior to

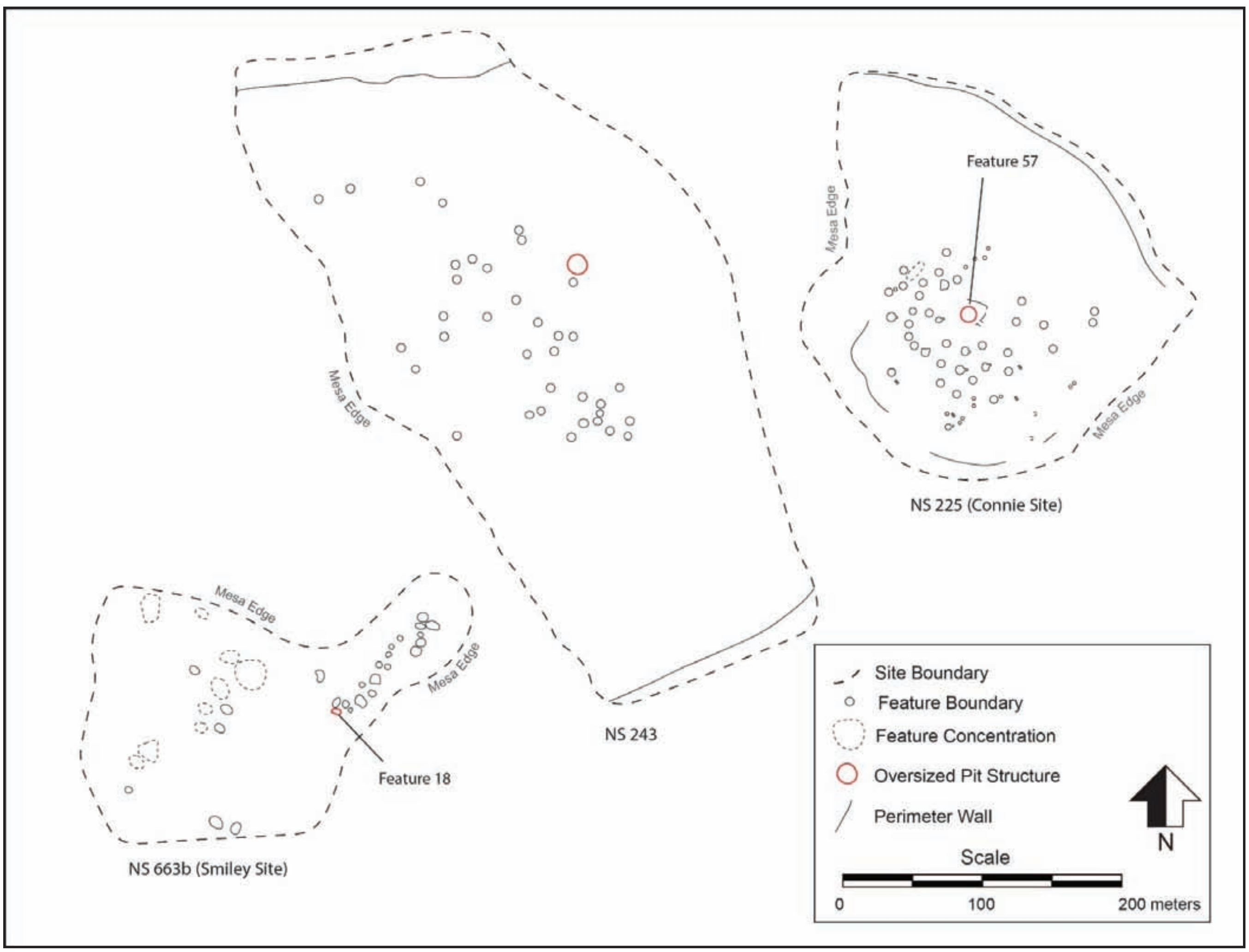

Figure 12. Comparison of large early agricultural settlements including the Smiley Site (NS 663a), Connie Site (adapted from Rogge et al. 2015:317, Figure 17.3), and NS 243 (adapted from Rogge et al. 2015:337, Figure 17.15).

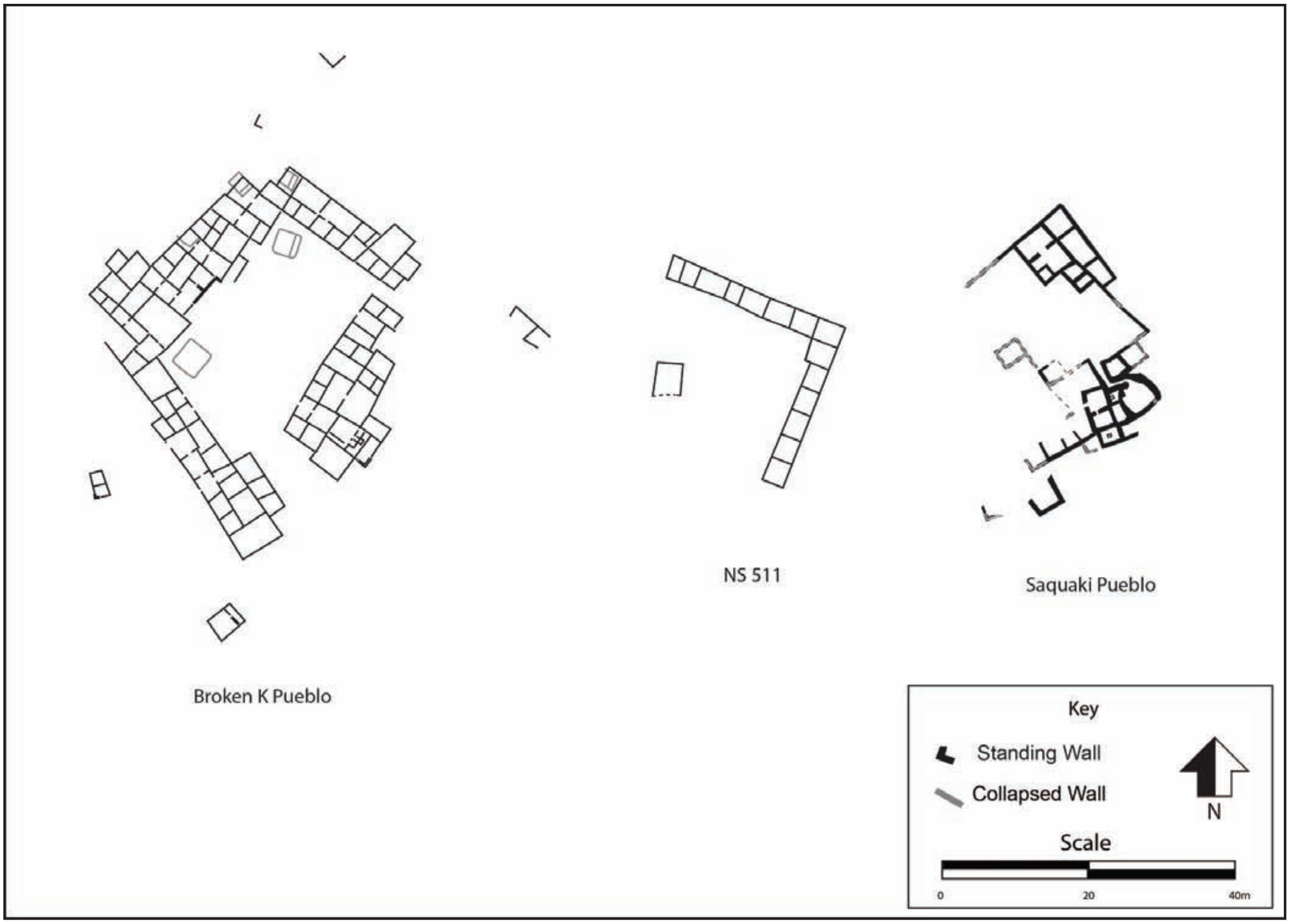

Figure 13. Comparison of Broken K Pueblo (adapted from Martin 1967:18-19, Figure 1), NS 511 (adapted from Zubrow 1971:161, Figure 24), and Saquaki Pueblo.

the complete depopulation and migration of Ancestral Pueblo people from the study area, social groups began experimenting with different adaptive strategies that included settling in areas higher in elevation with less perennial water. Large-scale social transformations in the Cibola region beginning around AD 1175 (i.e., Peeples 2011) may have been predicated on the need for Ancestral Pueblo people to recognize the constraints of the natural environment in ways their ancestors, a relatively small population of mobile hunter-foragers composed of nuclear or extended family groups, never could have imagined (Stuart 2014:10). The collection of more data and the development of more specific research questions relating to the interplay of social and ecological systems over time will hopefully provide greater insights into the long-term adaptability of the Ancestral Pueblo people and their descendants.

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Cover: The montage is a partial image of Feature 1918, an adobe-walled storage room, at the Lower Santan Village site with an inset photograph of two granary pedestals in situ on the floor (bottom right) and an artist's conception of the storage room, as it may have appeared while in use (top left). Photograph by Thomas Ross (GRIC CRMP). Illustration by Scott Medchill.