Final Report on 2008 and 2009 Investigations at the 3-Up Site, LA 150373, and Gamalstad, LA 164472, Mule Creek, New Mexico

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The 2008 and 2009 field school staff included Principal Investigators Brett Hill (Hendrix College), Jeffery Clark (Archaeology Southwest), and Deborah Huntley (Archaeology Southwest), Field Supervisor Rob Jones (Archaeology Southwest and University of Arizona [UA]), and Assistant Field Supervisor Katherine Dungan (Archaeology Southwest and UA). In 2008 and 2009, Elizabeth May (UA) served as an Assistant Field Supervisor and Cook Extraordinaire. Katherine Putsavage (University of Colorado) was a volunteer Assistant Field Supervisor in 2009. Suzanne Eckert (Texas A&M) lent a hand in the field and in the ceramics lab. The 2008 Hendrix College field school students were Sara Hunter, Kelsey Parker, Ahren Wardwell, and Owen Wilkerson. The 2009 Hendrix College field school students were Seth Boren, Hannah Jane Carmack, Arielle Carroll, Caitlin McGeehan, DJ Mello, Lindsay Romaniello, and Langdon Sanders.

In the Archaeology Southwest laboratory, student volunteers Gabriella Soto and Sam Fisher assisted with artifact processing. Gabriella also sorted flaked stone artifacts for subsequent analyses. Ceramic analysis was completed by Katherine Dungan with the assistance of Deborah Huntley and Gabriella Soto. Neutron Activation Analysis (NAA) was performed at the University of Missouri Research Reactor. Mary Ownby (Desert Archaeology, Inc.) completed the petrographic analysis and conducted the NAA statistical analysis (with valuable input from Jeffrey Ferguson of MURR). Britt Starkovich (Eberhard Karls Universität Tübingen, Institut für Naturwissenschaftliche Archäologie) analyzed the 2008 faunal assemblage; Lewis Borck (UA) analyzed 2009 faunal materials from Unit 301. Michael Diehl (Desert Archaeology, Inc.) completed the paleobotanical analysis, Lauren Falvey (Desert Archaeology, Inc. and University of Nevada, Las Vegas) analyzed ground stone artifacts, and Christine Virden-Lange (Desert Archaeology, Inc.) analyzed shell artifacts. Flaked stone analysis was completed by Stacy Ryan (Desert Archaeology, Inc.). Leslie Aragon (Desert Archaeology, Inc.) wrote much of the culture history overview in Chapter 1. Katherine Dungan created site location maps and plan views. Additional graphics were provided by Catherine Gilman (Desert Archaeology, Inc.).

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CHAPTER 1

INTRODUCTION

Deborah L. Huntley and Leslie D. Aragon

In 2008 and 2009, researchers from Archaeology Southwest (formerly the Center for Desert Archaeology) and the University of Arizona (UA) in Tucson partnered with Hendrix College (Arkansas) to conduct archaeological investigations in Mule Creek, New Mexico. Several private landowners granted access to land along Mule Creek, which allowed the Mule Creek Archaeological Testing Project (MCAT) to conduct test excavations at the previously recorded 3-Up site, LA 150373 [or NM S:13:4 (ASM)]. Limited testing was also conducted in 2008 and 2009 at the newly recorded Gamalstad site, LA 164472 [or NM S:13:10 (ASM)] (Chapter 7, this volume). In addition, several previously recorded sites were revisited, and several new sites were recorded, most of which are small room blocks or artifact scatters on the terraces above Mule Creek (Chapter 8, this volume). During both field seasons, students from Hendrix College were trained in field and analysis methods as part of an archaeological field school.

The research reported here is part of a larger interdisciplinary investigation into late prehistoric community formation and dissolution in the Upper Gila area of southeastern Arizona and southwestern New Mexico (Figure 1.1). The thirteenth through fifteenth centuries were times of demographic upheaval and population reorganization throughout the American Southwest. Previous research in the San Pedro and Safford areas has shown that migrants from the Kayenta/Tusayan region of northern Arizona moved into parts of southern and central Arizona beginning in the mid-thirteenth century (Clark 2001; Di Peso 1958; Lindsay 1987; Lyons 2003). These migrant communities maintained aspects of their northern traditions, including masonry architecture and Maverick Mountain series pottery, while interacting with local groups.

The proposal here is that migrant groups formed a diasporic community that shared a social identity despite living in enclaves throughout the southwest. The Upper Gila area seems to have been one of the few locations in the southern Southwest that experienced population growth during the late AD 1300s (Lekson 2002; Nelson and LeBlanc 1986; Wilcox et al. 2003), when many other aggregated communities were dissolving (Hill et al. 2004). The influx of diverse cultural groups into the Upper Gila area during the fourteenth century resulted in a diverse archaeological record that has been historically understudied.

3-UP SITE, LA 150373, DESCRIPTION

The 3-Up site is a multi-component pueblo located on a private ranch in Mule Creek, New Mexico (Figure 1.2). The site is directly adjacent to Mule Creek and near the perennial Mule Spring. The pueblo contains both adobe and masonry architecture, although limited testing, in conjunction with the impact of previous mechanical disturbance, makes it impossible to determine the number of rooms present. It is also not possible to identify any public architectural features such as kivas or plazas. Ceramics indicate the 3-Up site was occupied as early the Three Circle phase (AD 750–1000) through the Cliff phase (AD 1300–1450). Archaic projectile points found at the site indicate an even longer period of (probably) intermittent use. The extent to which later occupations were continuous is uncertain.

The 3-Up site has several spatially and somewhat temporally discrete loci that, together, cover approximately 300,000 m^2. Each locus is briefly summarized here, while testing results, as well as intrasite variability and chronology, are discussed later in this report.

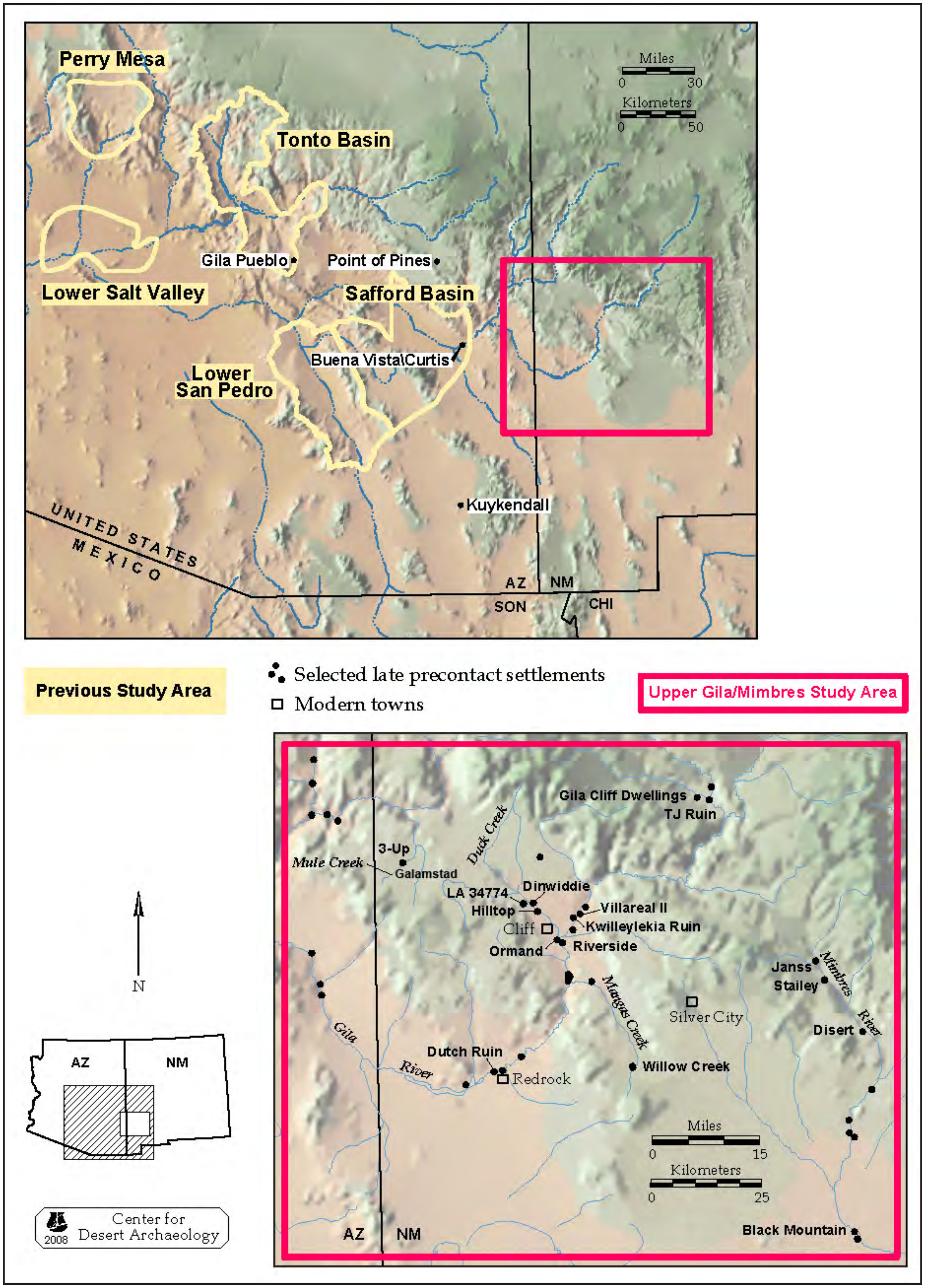

Figure 1.1. Previous study areas and the project study area.

Figure 1.2. Aerial view of the 3-Up site, LA 150373 (photograph by Henry D. Wallace).

Locus A, positioned atop a natural hill that slopes down to the terrace above Mule Creek, is the largest and most deeply stratified area of the site. This portion of the site contains the largest concentration of visible surface architecture, both adobe and cobble masonry. Locus A appears to have been in use throughout the occupation span of the site; the locus has also sustained the most damage, with evidence of both hand and mechanical looting and deep bulldozer cuts.

Locus B is on another natural hill located southeast of Locus A. Mechanical damage is also heavy in Locus B.

Locus C is spatially isolated—approximately 300 m south of the main site—and it consists of two small natural hills topped with adobe architecture.

Locus D, likely a small, melted adobe room block, is located on a natural rise southwest of Locus A. Surface artifacts are rare here. This locus shows no obvious evidence of looting.

Locus E is probably a medium-sized melted adobe room block with cobble footer stones. It is about 100 m southwest of Locus A and is not obviously elevated or mounded. The western and southern room block margins have heavy bulldozer disturbance.

Locus F, located on a low rise between Locus A and Mule Creek, is a small, melted adobe room block with cobble footer stones. Bulldozer disturbance is apparent at the edges of the architectural area.

Locus G is on a small rise just north of Locus F. A small, melted adobe room block occupies the western side of this small rise, and a series of cobble alignments just to the east suggest the remains of either cobble masonry or jacal walls near the slope above Mule Creek. A shallow looter's pit is present in the center of one of the cobble-walled rooms.

ENVIRONMENTAL BACKGROUND

Mule Creek is located in the Mogollon-Datil Volcanic field, a 50,000-km^2 area of primarily Tertiary-age volcanics on the southeast margin of the Colorado Plateau. Mule Creek flows out of the Sunflower Mesa and Big Lue Mountain area and enters the valley from the southwest. The creek runs along a relatively low grade for approximately 6.5 km, forming a fairly well-watered floodplain. Mule Creek joins with Tennessee Creek just north of Highway 78 and, from there, flows into a steep canyon that drops nearly 300 m to the San Francisco River. Vegetation in the valley is primarily a mixture of Chihuahuan desert scrub and grassland, with a rich riparian corridor along the creek itself and its tributaries.

Blue grama (*Bouteloua gracilis*) and other grasses, pinyon, and juniper dominate the valley (Figure 1.3), while the riparian corridor contains cottonwoods (*Populus fremontii*) and desert willow (*Chilopsis linearis*), in addition to other riparian species (Figure 1.4). The site itself had not been grazed in several years when it was tested, and it was covered with high grass and wild sunflower (*Helianthus annuus*).

Figure 1.3. Grassland environment of the 3-Up site, LA 150373, with Locus A in the background.

Figure 1.4. Riparian area near the 3-Up site, LA 150373.

The town of Mule Creek is close to the center of the Mule Creek obsidian distribution (Shackley 2005). Obsidian nodules from Mule Creek (including Mule Creek/North Sawmill Creek, Mule Mountains, and Antelope Creek localities within the Mule Creek source) were widely traded prehistorically (Shackley 2010). Two chemically distinctive obsidian localities, the Antelope Creek and the North Sawmill obsidians, are available within a few miles of the valley bottom and are abundant in the bedload of Mule Creek itself (Figure 1.5).

The Mule Creek/North Sawmill Creek obsidian takes the form of marekanites of variable size formed in pyroclastic tuff deposits. Nodule size is less than 10 cm, with most surface nodules averaging 5 cm or smaller. In contrast, the Antelope Creek obsidian takes the form of marekanites eroding out of perlitic lava beds west of Mule Creek,and is similar in size and quality to the Mule Creek/North Sawmill obsidian.

CULTURAL BACKGROUND

The following is a brief outline of general trends in the prehistory of the Mule Creek area and the Upper Gila region. The culture history of these areas, which fall within the archaeologically defined Mogollon, Classic Mimbres, and Salado cultural traditions, is similar to that of southwestern New Mexico in general (Table 1.1).

Figure 1.5. Marekanites for experimental flintknapping collected from the Mule Creek streambed.

Early Pithouse Period (AD 200–550)

The Early Pithouse period, or Cumbre phase, dates between about AD 200 and 550. Characteristic architecture of this time period consists of shallow round, oval, or amorphous pithouses (Diehl and LeBlanc 2001). Diagnostic ceramics include plain brown ware and Mogollon Early Red (Gilman 1980). Early Pithouse period settlements are often small and are found on mesas or hilltops and may attest to a need to settle in defensible locations (LeBlanc 1980a), although this theory has been challenged (Schutt et al. 1994; Wallace 1998).

Table 1.1. Upper Gila regional chronology.

Period, Phase	Date (AD)	Architecture	Diagnostic Ceramics
Post-Classic			
Cliff	1300–1450	Adobe pueblos	Gila Polychrome, Cliff Polychrome
Black Mountain/ Tularosa	1180–1300	Adobe pueblos/masonry pueblos	El Paso Polychrome, Chupadero Black-on-white/Tularosa Black-on-white, St. Johns Polychrome
Classic Mimbres	1000–1130	Cobble masonry pueblos	Mimbres Classic Black-on-white (Style III)
Late Pithouse			
Three Circle	750/800–1000	Rectangular pithouses	Three Circle Red-on-white, Mimbres Black-on-white (Styles I and II)
San Francisco	650/700–800	Rounded rectangular pithouses with ramps	Mogollon Red-on-brown
Georgetown	550–650/700	Circular or D-shaped pithouses with ramps	San Francisco Red
Early Pithouse			
Cumbre	200–550	Circular, oval, and amorphous pithouses with ramp or vestibule	Plain wares, Mogollon Early Red

Note: After Lekson (1990:3) and Brody (2004:31).

People pursued a mixed subsistence strategy, characterized by a reliance on hunting and gathering wild resources, with corn agriculture moderately important for diet augmentation (Diehl and LeBlanc 2001; Wallace 1998).

Late Pithouse Period (AD 550–1000)

The Late Pithouse period (composed of the Georgetown, San Francisco, and Three Circle phases) begins around AD 550 and lasts until AD 1000, although the controversial, transitional Mangas phase is sometimes placed at AD 900–1000 (Lekson 2002). This period is characterized by deeper, more formalized pithouses with ramped entryways that shift from circular to rectangular through time, as well as intramural subfloor burials. Large pithouse villages, located on terraces above river drainages, are known from this time period (Wallace 1998:4; Woosley and McIntyre 1996). This settlement pattern (along with other evidence) suggests a greater reliance on corn (Diehl and LeBlanc 2001). Diagnostic ceramics include San Francisco Red, Mogollon Red-on-brown, Three Circle Red-on-white, and Mimbres Black-on-white (Styles I and II). Larger sites dating to the Late Pithouse period often contain one or more oversized communal pit structures, typically labeled "great kivas" (Anyon and LeBlanc 1980; Hegmon et al. 1999).

Classic Mimbres Period (AD 1000–1130)

The Classic Mimbres period in the Upper Gila lasts from AD 1000 to 1130 and represents the highest population levels in the Upper Gila (Lekson 1990, 1992, 2002). In the Upper Gila, this time period is marked by the presence of a few large stone masonry pueblos of up to 200 rooms, in addition to several much smaller sites (Lekson 1992). Burials are typically subfloor inhumations. A single bowl, which almost always has a 1–2 cm "kill hole" punched out of the bottom, is often inverted over the heads of burials (Lekson 2002). Agriculture during this period is thought to have been based on canal irrigation and systems of check dams and terraces along the drainages (Lekson 1992). Diagnostic ceramics include Mimbres Black-on-white (Style III) and plain coil and indented corrugated brown ware (Hegmon et al. 1999).

Post-Classic Period, Black Mountain Phase and Tularosa Phase (circa AD 1180–1300)

The twelfth through thirteenth century Post-Classic Mimbres period occupation of southwestern New Mexico remains problematic. In the Upper Gila region, the Redrock and Cliff Valleys south and southeast of Mule Creek were occupied only sparsely during this time period (Fitting 1972; Lekson 2002). The Mimbres Valley to the east is characterized by the still inadequately understood Black Mountain phase (Blake et al. 1986; Creel 1999; LeBlanc 1980b; see also Nelson and LeBlanc 1986).

LeBlanc (1980b) defined the Black Mountain/Tularosa phase, dating AD 1180–1300, as a local development of the Casas Grandes system; however, the prevailing view sees this more as a time of population reorganization (Nelson and LeBlanc 1986), with continuity in ceramic traditions, architecture, and burial practices. Adobe construction replaces stone architecture, and subfloor urn cremations with "killed" bowl lids generally replace inhumation burials (Lekson 1992; Wallace 1998). Ceramic assemblages include imported types such as Playas Red, Chupadero Black-on-white, and El Paso Polychrome. Creel (1997) suggests Black Mountain phase sites contain high numbers of El Paso Polychrome and a continuing production of Classic Mimbres Black-on-white pottery. This may indicate cultural ties to the Casas Grandes influence in the El Paso area (Wallace 1998:6).

Also in the late twelfth and early thirteenth century, the southern edge of the Tularosa horizon, centered in west-central New Mexico and east-central Arizona, approached the eastern Safford Basin (Lekson 1996) and extended to Glenwood (Accola 1981; Robinson 1992), the Gila Cliff Dwellings (Anderson et al. 1986), the Black Range, and the Eastern Mimbres area (Laumbach 1992; Laumbach and Wakeman 1999; Nelson 1999). The Fornholt site, LA 164471, located just north of the 3-Up site, is one such Tularosa phase pueblo with likely cultural ties to the north and west (Dungan 2015).

To complicate the chronology, beginning in the late 1200s or early 1300s, there is evidence for migration of people out of the Kayenta and Tusayan regions in northeastern Arizona. Over a period of a few generations, groups of migrants relocated to the southern Southwest, where they encountered large and established Hohokam irrigation communities in southern Arizona (Clark and Lyons 2012; Di Peso 1958; Haury 1945; Lindsay 1987; Lyons 2003; Lyons et al. 2011) and probably smaller post-Classic Mimbres and Ancestral Pueblo populations in southwestern New Mexico (Dungan et al. 2012; Huntley et al. 2010). In the greater Upper Gila region and elsewhere in the southern Southwest, Kayenta enclaves are characterized by the presence of Maverick Mountain series ceramics, locally made copies of Kayenta pottery (Lindsay 1987, 1992; Lyons 2003; Neuzil and Lyons 2006), and distinctive perforated plates likely used for pottery manufacture (Christiansen 1994; Lyons and Lindsay 2006).

Post-Classic Period, Cliff Phase (AD 1300–1450)

Fourteenth century Cliff phase sites mark the return of large, aggregated populations to much of the Mimbres area. Along with newly established sites, there is also evidence for a Salado overlay on many former Classic Mimbres sites (Lekson 2002; Nelson and LeBlanc 1986). Salado sites in the Mimbres area are concentrated in the Cliff Valley, leading to the definition of the fourteenth and early fifteenth century Cliff phase (Nelson and LeBlanc 1986).

Characteristics of this phase are large pueblos made from puddled or coursed adobe with basal rows of upright stones, or *cimientos*, for reinforcement. Kivas or other communal structures are generally not part of Upper Gila Salado settlements (but see Wallace 1998 for a description of a communal structure at Ormand Village, LA 5793), although plaza areas often occur. According to Lekson (2002:4), Salado villages in the Upper Gila were almost certainly dependant on canal irrigation. Burial practices are extremely diverse and include subfloor inhumations, subfloor urn cremations, and urn cremations in cemetery areas. Salado Polychrome ceramics are diagnostic of this phase, especially Gila, Cliff, and Dinwiddie polychromes (Lyons 2004; Neuzil and Lyons 2006) at excavated Upper Gila villages.

The time between the end of the Cliff phase and the first written records of this area has seen little archaeological study. By the time of written records, the area was home to mobile Apache people. Archaeological sites from this time period are subtle and have been difficult for archaeologists to recognize.

CHAPTER 2

ARCHAEOLOGICAL INVESTIGATIONS

Deborah L. Huntley and Leslie D. Aragon

RESEARCH THEMES

Archaeology Southwest's research in the Upper Gila area and the greater Mimbres region of southwestern New Mexico focuses on three major research objectives. The first goal is to determine the scale of Kayenta immigration from northeastern Arizona into the Upper Gila area and Mimbres Valley in the late thirteenth or early fourteenth century AD and to assess the social context in which this movement occurred. The second goal is to evaluate the scale of subsequent immigration of culturally mixed "Salado" groups from southeastern Arizona into these valleys during the fourteenth century AD. The third and final goal is to explore models for community organization during the tumultuous fourteenth century.

The focus of this research is on the extent to which community organization during this pivotal period corresponded to a coalescent or diasporic model (Clark et al. 2013). Coalescent communities share a place but are separated by culture. Diasporic communities share a culture but are separated by space. These community forms are not mutually exclusive, however. Rather, aspects of each may exist simultaneously, and those aspects may be emphasized or downplayed during particular times or under certain circumstances.

ARCHAEOLOGICAL SETTING

The Upper Gila and its tributaries along with the Mimbres Valley to the east (see Figure 1.1) have been inhabited by hunter/gatherers and agriculturalists for more than a millennium. Productive agricultural land and perennial water in the Mule Creek area and in the Upper Gila region in general may have attracted people to this area during the late thirteenth century, when other areas in the Southwest were being depopulated. For both local and immigrant populations, one of the principal attractions of Mule Creek was undoubtedly the abundant availability of obsidian. We have suggested elsewhere that the Kayenta (and, later, Salado) groups at the 3-Up site, LA 150373, were circulating Mule Creek obsidian through a regional diasporic network to settlements in southwestern New Mexico and southeastern Arizona (Clark and Lyons 2012; Clark et al. 2013; see also Neuzil 2008).

Unfortunately, many archaeological sites in the Upper Gila region have been the target of looting and vandalism due to their decorated pottery. The few scientific excavations that have been conducted on sites contemporaneous with the thirteenth and fourteenth century components at the 3-Up site were performed by avocational archaeologists (e.g., Jack and Vera Mills [1972] and "Red" Ellison at Kwilleylekia Ruins) or were a part of salvage operations before modern archaeological methods were widely used (see Dittert 1966; Hammack et al. 1966; see also Wallace 1998), with a few notable exceptions (see Lekson 2002; Nelson and LeBlanc 1986). Thus, many collections were not obtained using currently accepted archaeological excavation techniques, nor were they studied using the most current analytical techniques. A few of these excavations from the relatively well-known Cliff Valley east of Mule Creek are summarized here.

Ormand Village, LA 5793, is a large adobe pueblo located near Cliff, New Mexico on a gravel terrace just west of the Gila River (Wallace 1998). It was excavated as part of the Cliff Highway Salvage Project in the mid-1960s by the Museum of New Mexico (Dittert 1966; Wallace 1998). Ormand Village includes a substantial Cliff phase/Salado occupation. A possible late Archaic or Mogollon Early Pithouse period component and a small Mogollon Late Pithouse period component are also present. The excavators noted that some of the pithouses attributed to the Late Pithouse period may actually belong to the earliest Salado occupation from around AD 1300 (Wallace 1998:17). The Cliff phase component includes several adobe room blocks totaling at least 150 rooms, a central plaza, a large ceremonial structure, and two cremation areas. Ormand Village produced a large collection of ceramics, flaked stone, and other artifacts, which is curated at the Laboratory of Anthropology in Santa Fe, New Mexico.

Kwilleylekia Ruins, LA 4935, were excavated from the 1960s to the 1980s by Richard "Red" and Virginia Ellison (Lekson 2002). This multi-storied adobe pueblo reportedly had more than 200 rooms in two room blocks. Possibly one of the latest—if not the last—settlements in the Cliff Valley, Kwilleylekia appears to be a single-component site. Based on conversations with Ellison, Lekson (2002) reports that large quantities of Salado polychromes were found at Kwilleylekia. Ellison also claimed to have recovered Rio Grande Glaze C and D pottery (Lekson 2002). Perforated plates have been found at the site (Di Peso 1981:114). Unfortunately, the assemblage, which includes whole vessels, rumored (but never reported) archaeomagnetic dates, and tree-ring dates, is now dispersed, having never undergone formal study.

The Dinwiddie site, LA 106003, an 80- to 100-room adobe pueblo south of Duck Creek near Cliff, New Mexico, has also been the subject of past archaeological investigations. During the late 1960s, avocational archaeologists Jack and Vera Mills, with permission from Mr. and Mrs. Richard Dinwiddie, conducted survey work and excavations at the Dinwiddie site (Mills and Mills 1972). The Mills excavated in two adobe room blocks, House 1 (5 rooms excavated) and House 2 (32 rooms excavated). Several of the interior rooms in House 2 were reportedly two stories high, with single-story rooms along the south and west sides. A large collection of whole vessels and other artifacts from the Mills' excavations at the Dinwiddie site and other sites in southwestern New Mexico and southeastern Arizona is housed in the Student Services Building at Eastern Arizona College (EAC) in Thatcher, Arizona.

In 2004, archaeologists from the Center for Desert Archaeology (now Archaeology Southwest) conducted an analysis of more than 300 vessels from this collection (Neuzil and Lyons 2006). This study helped refine the ceramic chronology for the region. Although the Mills' collection at EAC contains whole vessels and other exotic or unique artifacts, bulk collections of artifacts from the Dinwiddie site have not been located, nor have the Mills' excavation notes.

In the summers of 2013–2015, researchers from Archaeology Southwest and the University of Arizona conducted archaeological investigations at the Dinwiddie site as part of the Preservation Archaeology Field School. Excavation units tested deposits in sheet midden areas around the site and rooms in the areas the Mills referred to as Houses 1 and 2. Additional test units revealed some intact room fill in a third room block to the south, which has been largely destroyed by a modern road. Evidence for Kayenta migrants is scant at the Dinwiddie site, consisting of just two sherds of perforated plates and a small amount of Maverick Mountain series polychromes (31 sherds, less than 2 percent of the decorated assemblage). The results of the 2013–2015 field seasons at Dinwiddie will be presented in a future report.

As part of the Mule Creek Archaeological Testing Project (MCAT), which investigated the 3-Up site in 2008 and 2009, limited test excavations at Gamalstad, LA 164472, an extensively damaged site with a small Cliff phase component located approximately 0.5 mile north of the 3-Up site, were also conducted. Results from this testing are presented in Chapter 7 (this volume). In both 2011 and 2012, the joint Archaeology Southwest/University of Arizona Preservation Archaeology Field School conducted test excavations at the Fornholt site, LA 164471, also in Mule Creek. The results of this work at Fornholt are reported in Dungan (2015) and will be expanded upon in a future report.

PREVIOUS RESEARCH AT THE 3-UP SITE, LA 150373

The 3-Up site was recorded and mapped in 1977 by the Mimbres Foundation, and it was subsequently revisited and tested by Arizona State University's (ASU) Mogollon Prehistoric Landscapes Project (Schollmeyer et al. 2007). ASU's investigations revealed several spatial and temporal components, designated Loci A–G (Table 2.1; also, Chapter 1, this volume).

The 1977 Mimbres Foundation report recorded very little disturbance at the site other than some hand-excavated potholes. In the intervening three decades, however, several large bulldozer trenches were cut through the site, substantially disturbing some of the features visible on the 1977 map. The ASU researchers created a map of visible wall alignments and areas of surface adobe melt during their 2007 field season (Schollmeyer et al. 2007), made several surface collections, and excavated four small test units aimed primarily at cleaning profiles in existing bulldozer cuts to examine stratigraphy in the cultural deposits.

Loci A–C were the primary focus of ASU's test excavations (Figure 2.1; Table 2.2) (see Schollmeyer et al. 2007). A brief summary of their results is provided here. Two units, Units 101 and 102, were excavated at Locus A. Unit 101 was placed near a masonry wall stub visible in the bulldozer cut. This unit exposed several vertically stratified occupation episodes, including a Three Circle phase pithouse, Tularosa or Black Mountain phase cultural fill and extramural hearth, and a two-story Cliff phase room. The ASU researchers note that this room may represent either two separate occupations or a single occupation with substantial remodeling.

Excavation in Unit 102 revealed evidence of two separate occupation episodes. The upper occupation consisted of a likely Cliff phase masonry room (dating based on associated ceramics), while the lower occupation was represented by a room with a single-course adobe wall remnant. Ceramics on a portion of intact floor in this lower room (including portions of a Tularosa Fillet Rim bowl) suggest a Tularosa phase occupation that may be contemporaneous with the lower deposits in Unit 101.

ASU researchers excavated one test unit in a bulldozer cut in Locus B, revealing deep deposits within an adobe room block. Two different cultural deposits were evident. The lowermost was a circa 10-cm-deep

Table 2.1. Summary of loci at the 3-Up site, LA 150373.

Locus	Unit(s) Excavated	Feature Type	Time Periods	Deposit Depth	Associated Subfeatures
A	ASU 101, 102; CDA[a] 301	Multiple, superimposed adobe and masonry room blocks; pithouse	Early Pithouse period, Classic Mimbres, Tularosa/Black Mountain phase, Cliff phase	3.0 m+	Extramural hearth, subfloor pit, storage pit, possible posthole
B	ASU 201; CDA 103, 104, 105	Adobe room blocks	Classic Mimbres (surface sherds), Tularosa/Black Mountain phase, Cliff phase	2.0 m+	Posthole, pit
C	ASU 301; CDA 106, 107, 108	Adobe room blocks	Cliff phase	2.0 m+	Small pit
D	None	Adobe room block	Tularosa/Black Mountain phase	Unknown	–
E	None	Adobe room block	Cliff phase	Unknown	–
F	CDA 101	Adobe room block	Cliff phase	<1.0 m	–
G	CDA 102	Adobe room block, possible cobble masonry	Classic Mimbres?, Tularosa/Black Mountain phase?	<1.0 m	Pit

[a]Excavations were conducted by the Center for Desert Archaeology (now Archaeology Southwest).

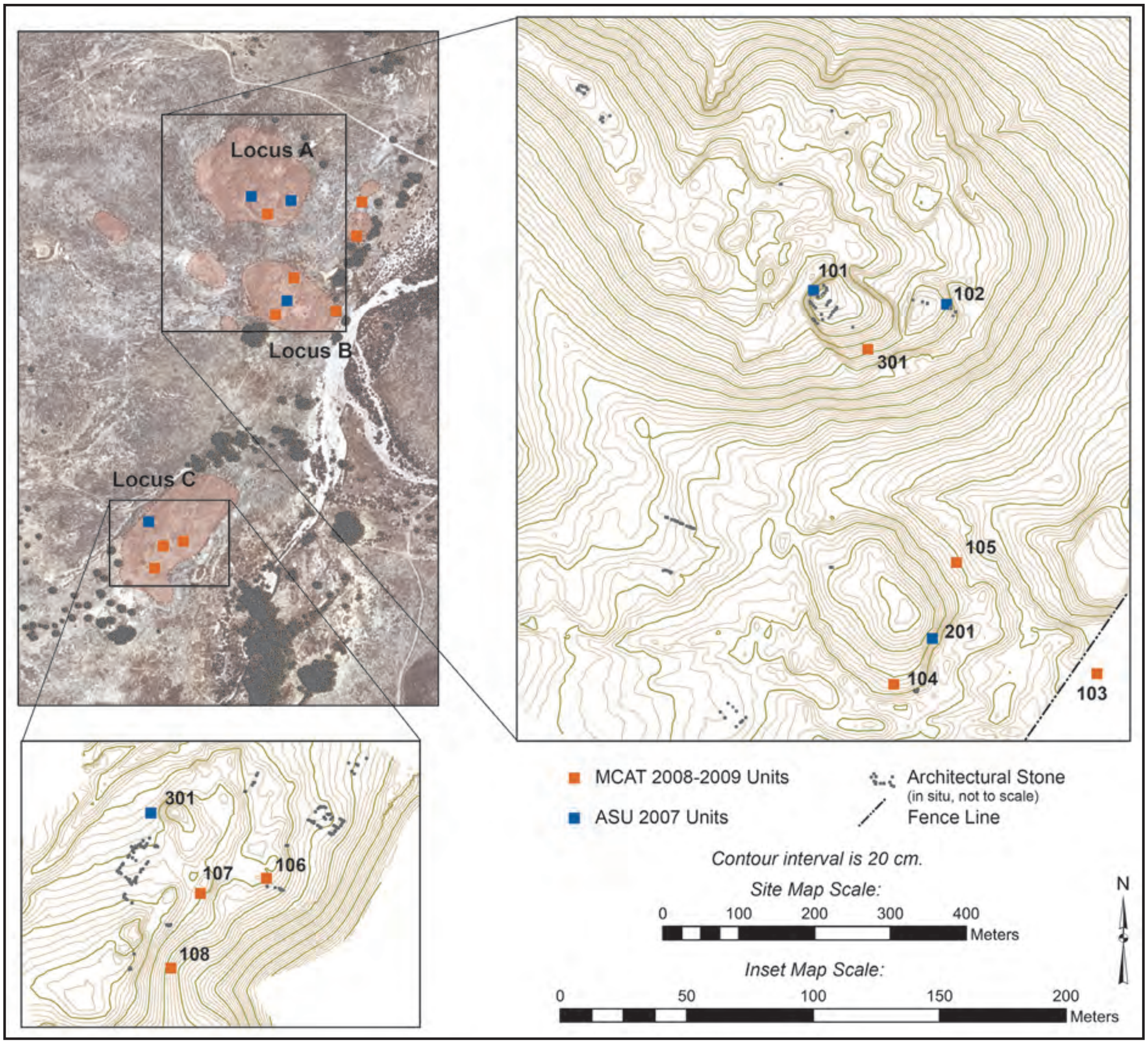

Figure 2.1. Plan view of the 3-Up site, LA 150373, showing loci and excavation units.

layer of trash fill containing Tularosa or Black Mountain phase ceramics and capped by a daub surface. This was overlain by additional layers of cultural fill, including portions of at least two patchy, Cliff phase plaster surfaces. No walls were encountered.

A single test unit in a bulldozer cut in the northern portion of the adobe mounded area in Locus C revealed more than 2 m of cultural deposits. This unit contained three superimposed floors or other cultural surfaces and associated fill, all of which appear to date to the Cliff phase. All three surfaces were poorly preserved. As in Locus B, no walls were found during test excavations.

Based on their findings, ASU researchers concluded that all three tested loci had substantial surface deposits dating to the Cliff phase in addition to earlier deposits in Locus A. ASU's surface ceramic collections suggested that Loci E and F also contained Cliff phase deposits. Locus D appeared to be a Black Mountain or Tularosa phase occupation based on surface ceramics, while Locus G was determined to be of ambiguous temporal affiliation.

ARCHAEOLOGY SOUTHWEST METHODS AND SCOPE OF WORK

The primary goal of the 2008 and 2009 test excavations was to sample midden trash associated with room blocks to maximize the temporal span of the artifact sample with minimal impact to the site. Excavations focused on Loci B and C, with additional tests in Loci A, F, and G (Table 2.3). Excavation units were placed outside of visible architecture in areas with relatively dense but unstructured surface artifact scatters in the hope of finding stratified trash deposits. It was difficult to reliably place units in middens and avoid architecture based on site surface characteristics.

Nine 2-m by 2-m control units were excavated in five loci (see Table 2.3). These units were excavated in 10-cm-deep arbitrary levels following landform contours whenever possible. Depths were measured from a

Table 2.2. Arizona State University units, by locus, at the 3-Up site, LA 150373.

Locus, Unit	Depth (m)	Size (m)	No. of Levels	Contexts	Associated Feature Nos.
Locus A					
101	3.25	1.0 by 1.5	21	Pithouse, trash fill, lower and upper room fill[a]	101–15/16-3 (extramural hearth) 101-21-4 (subfloor pit)
102	1.06	2.0 by 2.0	7	Midden, floor fill, lower and upper room fill	102-6-4 (storage pit) 102-6-5 (posthole)
Locus B					
201	2.46	1.0 by 2.0	11	Trash fill, layered fill and ash, middle and upper cultural surface and fill	201-9-3 (posthole)
Locus C					
301	2.30	1.0 by 2.0	16	Lower, middle, and upper cultural surface and fill, disturbed backdirt	–

[a]Arizona State University researchers used the unit-level-system, assigning separate locus numbers to discrete contexts (see Schollmeyer et al. 2007).

Table 2.3. Archaeology Southwest test excavation units, by locus, at the 3-Up site, LA 150373.

Locus, Unit	Depth (m)	Size (m)	No. of Levels	Contexts	Associated Feature Nos.
Locus A					
301	0.95	1.0 by 2.0	8	Possible middle	Feature 10 (midden)
Locus B					
103	~1.80	1.0 by 2.0	9	Adobe structure above middle	Feature 3 (adobe structure) Feature 9 (trash fill)
104	0.92	1.0 by 2.0	9	Trash concentration	Feature 4 (midden) Feature 6 (pit)
105	0.62	1.0 by 2.0	6	Trash concentration	Feature 5 (midden)
Locus C					
106	0.43	1.0 by 2.0	4	Adobe structure	Feature 7 (adobe structure)
107	0.30	1.0 by 2.0	3	Trash concentration	Feature 8 (small pit)
108	0.30	1.0 by 2.0	3	Sheet wash	–
Locus F					
101	0.62	1.0 by 2.0	6	Trash concentration	Feature 1 (trash midden)
Locus G					
102	0.53	1.0 by 2.0	4	Sheet wash	Feature 2 (pit)

unit-specific datum, the elevation of which was tied to the site datum using an auto level. Unit corners were recorded using a Trimble GPS unit and external antenna, allowing for sub-meter accuracy. Feature numbers were assigned to discernible cultural units within loci.

Most excavation was done with a shovel and a hand trowel, although a 5-lb pick was occasionally used to loosen sediment. All material was screened through ¼-inch screen. Except architectural material (wall fall and pieces of adobe), all artifacts were collected. Unmodified obsidian nodules, common at the site, were also collected. Units were excavated to culturally sterile soil except Units 103 and 106. All units were then photographed in plan and profile view using a digital camera. One profile view for the long axis of each unit was drawn, as was a unit cross section. When subfeatures, such as small features within rooms, were encountered, these were photographed and mapped in plan and profile view. Subfeature numbers were assigned consecutively with architectural and other feature numbers.

In addition to excavation units, limited surface collection was conducted to more fully characterize the range of ceramics represented at the site. Judgmental surface collections of diagnostic ceramics and lithic tools were made, and these were recorded by locus. Especially at Locus A, where no testing was conducted, this allowed a more accurate detailing of the range of ceramics associated with each room block.

Finally, sub-meter accurate Trimble GPS units were used to map the site in 2008 and 2009. The site map was created in ArcGIS 9.2 using the GPS data for unit and datum locations. UTM coordinates supplied by ASU researchers were used to plot their excavation units on a master map.

EXCAVATION UNIT DESCRIPTIONS

Unit 101

Unit 101 (Figure 2.2) was located on the south side of a small adobe room block in Locus F. The unit was placed outside obvious architecture on a gentle slope. The surface was relatively loose and ashy gray, with a 10- to15-cm-deep zone of root disturbance. Beneath this layer, sediment was dark brown clay loam, more compact than the layer above but still quite friable. Rodent disturbance was evident from 20–30 cm below surface (cmbs) but decreased with depth. Several large (6–35 cm) stones, possibly architectural material, were found at approximately 30 cmbs.

Figure 2.2. Photograph of Mule Creek Archaeological Testing Project Unit 101, Locus F, the 3-Up site, LA 150373.

Other potential architectural materials included pieces of burnt adobe. Due to relatively high artifact density and the presence of artiodactyl bone and ash, this deposit was considered a trash midden and was designated Feature 1. Abundant ceramics (Chapter

3, this volume) and flaked stone artifacts (Chapter 4, this volume) were recovered throughout the unit in addition to several large tabular stones with flaked edges interpreted as agave knives.

At approximately 30 cmbs, the proportion of sand increased and the ashy, dark gray midden soil of the midden graded into brown silty clay loam with a slightly platy structure. Large rocks decreased with depth. At roughly 50 cmbs, clay content increased, as did caliche nodules and angular gravels. Artifact size and frequency decreased at this depth, although charcoal flecking and small sherds and flakes were found throughout all levels. Brown, sterile, sandy clay was recorded between 60 and 70 cmbs. Sterile soil was hard and compact and included pea- to gravel-sized nodules of both caliche and obsidian.

The west unit wall shows the deposit sloping toward the south at an angle fairly consistent with the slope of the ground surface. This deposit is interpreted as a trash concentration or midden adjacent to the architecture visible on the surface of Locus F. The deposit slopes toward a slight draw south of the locus that presumably predates the room block.

Unit 102

Unit 102 was excavated just south of a melted adobe room block designated Locus G on a gentle slope into a draw. The surface was grayish-brown and slightly ashy, with a slightly higher artifact density than the surrounding area. The subsurface root zone was an approximately 10-cm-deep, light gray-brown sand clay loam with inconsistent compaction. Beneath the root zone was a 20-cm-thick zone of dark gray-brown sandy loam. This deposit contained a high organic content and some ceramics and flaked stone artifacts, but not a notably high artifact density. Minor root and rodent disturbance was noted for this deposit. Clay content increased with depth after approximately 25 cmbs, as did rodent disturbance.

In the south side of the unit, a small pit, designated Feature 2 (Figure 2.3), was detected based on differences in the fill of the north and south sides of the unit. The edge of this pit became more obvious as the north side of the unit transitioned to gray-brown silty clay, while the pit fill continued in the southern end of the unit. Pit fill was light gray-brown, soft, sandy clay loam, with higher artifact density than the rest of the pit. A mano, possibly resting against the sloped pit wall, was recovered from the edge of the pit. Rodent disturbance was high in the softer gray pit fill, which made defining the edge of the pit difficult on the north side.

Friable sterile pale orange-brown sandy clay was encountered at 53 cmbs in the area around the pit. The unit appears to have reverse stratigraphy, with preclassic Mimbres ceramics overlaying Salado ceramics. Artifact density was relatively low throughout, and sherds tended to be small and eroded, leading to an interpretation of this deposit as sheetwash from Locus A and/or Locus G.

Unit 103

Unit 103 was located on a ridgetoe downslope from the primary room block of Locus B, adjacent to a bulldozer cut but in apparently intact deposits. The root zone of this unit was relatively shallow. The remains of an adobe structure, Feature 3, were encountered at approximately 30 cmbs, exposing the corner and a section of eroded floor (Figure 2.4). Extensive associated wall fall adjacent to the adobe wall foot was interpreted as shaped stone masonry, which had toppled downslope as the house eroded. The masonry was probably alternating courses of worked stone and thin tabular chinking, although none was found intact to confirm this hypothesis (wall fall materials were analogous to those found on the top of Locus A; see Schollmeyer et al. 2007).

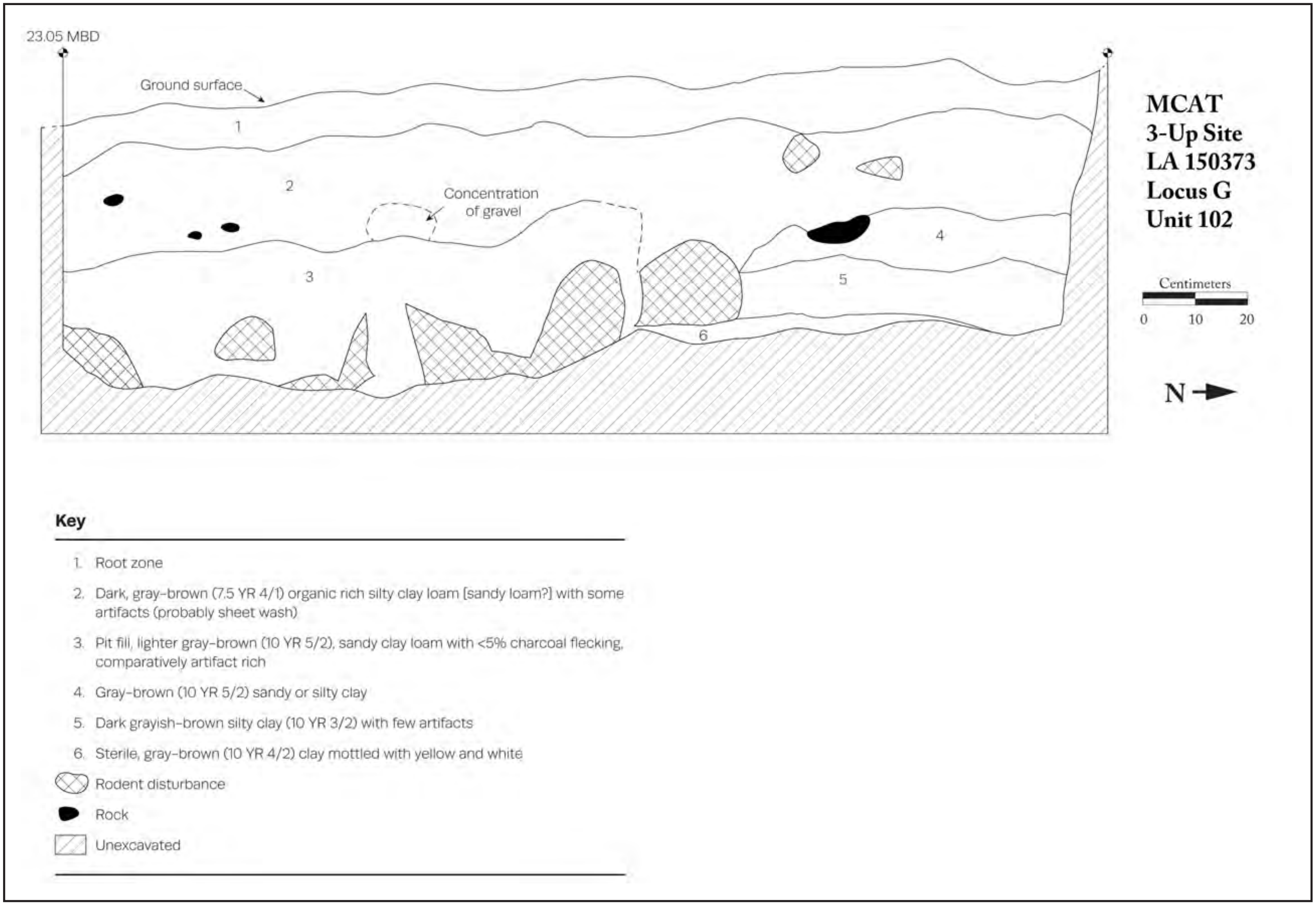

Figure 2.3. Mule Creek Archaeological Testing Project Unit 102, Locus F, west profile, showing the location of pit Feature 2, the 3-Up site, LA 150373.

Beneath the wall fall and the structure was an additional 160 cm of trash fill, designated as Feature 9, with abundant ceramics and other materials, apparently deposited on a slope. Sand lenses were apparent in the unit profile, but appear in a stratum that does not seem to be otherwise demarcated. Unit 103 was discontinued at about 190 cmbs due to safety concerns and the end of the field season; sterile had apparently had not yet been reached.

Figure 2.4. Photograph of the wall corner of Feature 3 in Mule Creek Archaeological Testing Project Unit 103, Locus B, the 3-Up site, LA 150373.

Unit 104

Unit 104 was located on the south slope of the low rise occupied by the primary room block of Locus B. The root zone here was very loose, grayish-brown,silty clay loam 15 cm thick, which overlay an increasingly compact, darker clay loam. This darker layer extended for approximately 15 cmbs before transitioning into soft, loose silty clay with abundant ash, charcoal, and artifacts. Rodent disturbance, though common throughout this deposit, was concentrated in this stratum. Burnt adobe pieces were recovered from this stratum, as was a very high density of animal bone. Some disarticulated human bone fragments were also recovered; these were later reburied in the unit.

Adobe pieces were common at approximately 60 cmbs, especially on the north side of the unit. At approximately 70 cmbs, a lens of more compact sandy clay was encountered extending from the north side of the unit. Beneath this stratum was compact, grayish-brown sediment. In the south side of the unit, melted adobe was encountered just above sterile. The north side of the unit was also more compact near the base, with gray-brown silty clay loam just above sterile. Gravels increased with depth, and friable pale orange-brown sterile sandy clay was encountered at a final depth of about 90 cmbs.

Feature 6 was an amorphous pit cut into the sterile at the base of Unit 104. This pit was cut rouoghly 25 cm into the sterile, although the upper pit boundaries were unclear. The pit edges were impacted by rodent disturbance, although the pit may have been circular prior to this disturbance (Figure 2.5). The pit was not detected until the base of Level 4. Artifacts in pit fill included a few sherds and flakes, but density was similar to the rest of the unit.

Artifact density was high throughout the deposits in Unit 104, and the layering of highly organic soils suggests fill events or periodic deposition along the slope. Due to the high density of artifacts and charcoal, as well as the organic soils, Unit 104 is interpreted as a stratified midden, designated Feature 4.

Unit 105

Unit 105 was placed on the north slope of the low rise defined as Locus B. The root zone was a relatively loose, artifact-rich layer of light gray sandy loam approximately 10 cm thick. Beneath the root zone was a 15-cm-thick, dark gray-brown, silty clay loam with some root disturbance. This layer was soft and artifact rich, grading into a gray, sandy clay loam with extensive charcoal flecking. A dark gray sandy loam was found only in the southern side of the unit; it extended to sterile. Sterile in this area was orange-brown mottled sandy to silty clay.

Deposits in Unit 105 were soft and charcoal flecked throughout, containing abundant ceramics, flaked stone artifacts, and animal bone (Figure 2.6). These are thought to represent a trash midden, designated Feature 5, downslope from the Locus B room block.

Figure 2.5. Photograph of the base of Mule Creek Archaeological Testing Project Unit 104, Locus B, with pit Feature 6, the 3-Up site, LA 150373.

Unit 106

Unit 106, part of Locus C, was located on a low rise adjacent to the floodplain of Mule Creek. The top levels of this unit were very compact sandy loam with extensive gravels throughout. Some rodent disturbance was noted, especially in the southwest corner of the unit. Small charcoal flecking was evident, and the unit had very low artifact density in the upper layer.

Beneath this stratum was a compact sandy loam with possible adobe melt throughout. This was designated Feature 7, an adobe structure, once this context became apparent. The compact sandy loam overlaid a well-plastered floor, which extended throughout the unit. Floor fill was somewhat softer and ashier than the room fill. The floor level contained several crushed reconstructible ceramic vessels and a portion of a perforated plate in floor contact (Figure 2.7). Several potential tree-ring samples were recovered from the roof fall and from floor contact; these were submitted to the Laboratory of Tree Ring Research at the University of Arizona with samples from ASU's 2007 testing. Unfortunately, none of the samples were datable. Unit 106 may have contained a cimiento adobe wall in the southeastern corner, visible as flat-sided stones embedded in the southern side wall. The floor was cleaned and mapped but excavation stopped at the floor.

Unit 107

Unit 107 was in relatively shallow deposits on a low rise adjacent to a visible room block, which is part of Locus C. The surface root zone was a grayish-brown compact soil with subangular gravels and caliche throughout. Beneath the root zone was a compact sandy clay loam, still grayish-brown and compact but with less root disturbance. Artifact density was very light throughout the unit, which was interpreted as sheetwash (no feature number assigned).

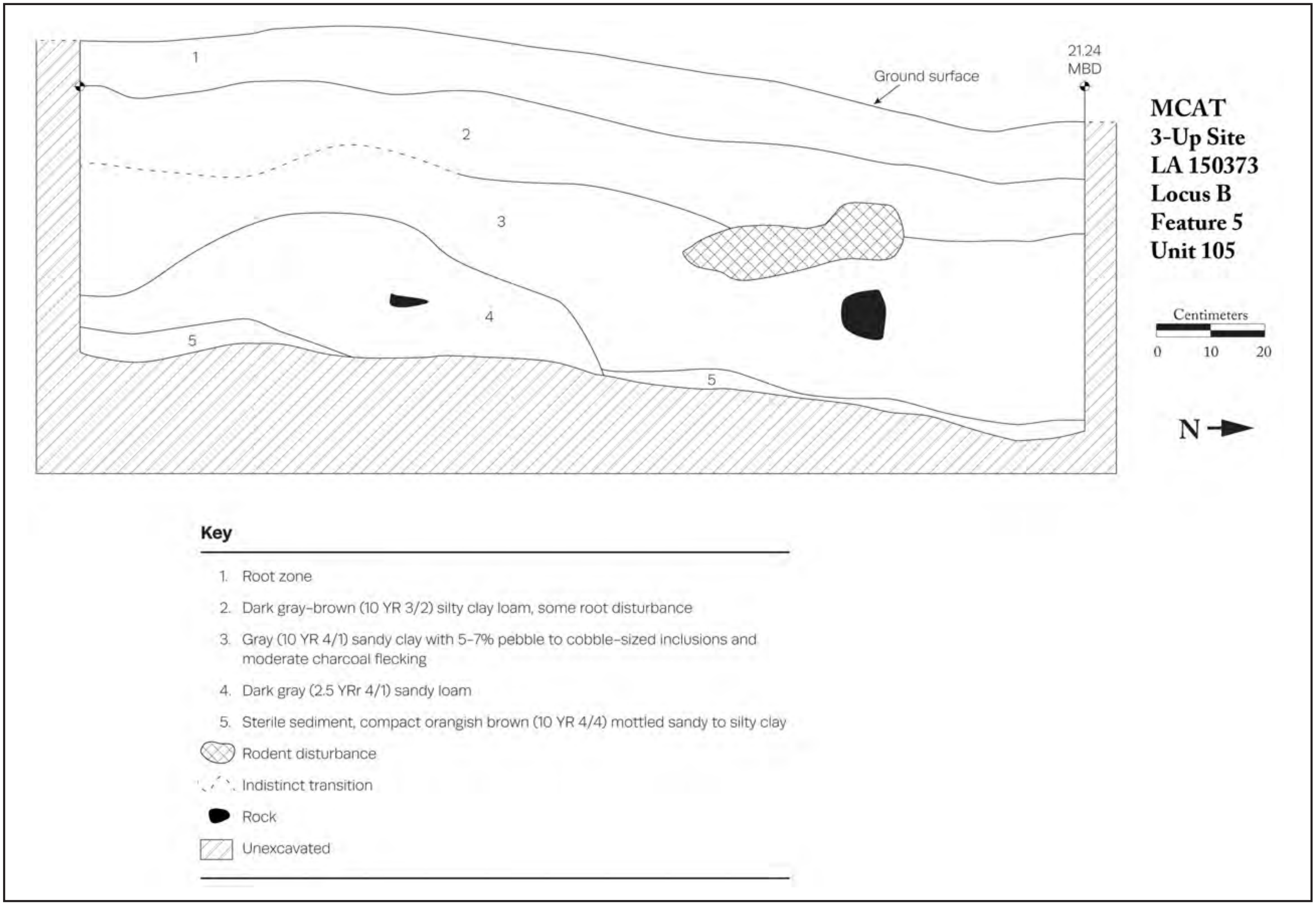

Figure 2.6. Mule Creek Archaeological Testing Project Unit 105, Locus B, west profile, the 3-Up site, LA 150373.

A reddish-brown, very compact, silty clay loam with a very high percentage of caliche and tuff was encountered at approximately 25 cmbs. This sterile stratum was cut by a small pit, Feature 8, encountered in the western portion of the unit (Figure 2.8). The pit had irregular edges and extended approximately 25 cm below the unit base. Pit fill was a mixture of gray-brown clay loam mixed with caliche-rich, reddish-brown silty clay loam similar to sterile. Pit fill was no more artifact rich than the unit in general; the function of the pit remains indeterminate.

Figure 2.7. Perforated plate fragment on the room floor in Mule Creek Archaeological Testing Project Unit 106, Locus C, the 3-Up site, LA 150373.

Unit 108

Unit 108 was placed on the slope of a small draw just east of Locus C. Beneath a thin layer of overburden, the deposit was extremely compact, with a high gravel content throughout (Figure 2.9). Sediments were hard silty clay with low artifact density, primarily flaked stone. Sterile sediments were encountered at approximately 25 cmbs. Here, sterile was dark yellowish-brown compact silty clay with gravel and caliche throughout. Based on the very high compaction and low artifact density, this unit was interpreted as sheet trash originating from Locus C.

Figure 2.8. Photograph of Mule Creek Archaeological Testing Project Unit 107, Locus C, showing pit Feature 8 extending into sterile soil, the 3-Up site, LA 150373.

Unit 301

The 2009 field season included a single test unit in Locus A to include comparable excavation data across the defined loci at the site. Unit 301 was placed downslope from the anthropogenic hill that forms the highest point of the site, away from obvious disturbance caused by mechanical looting.

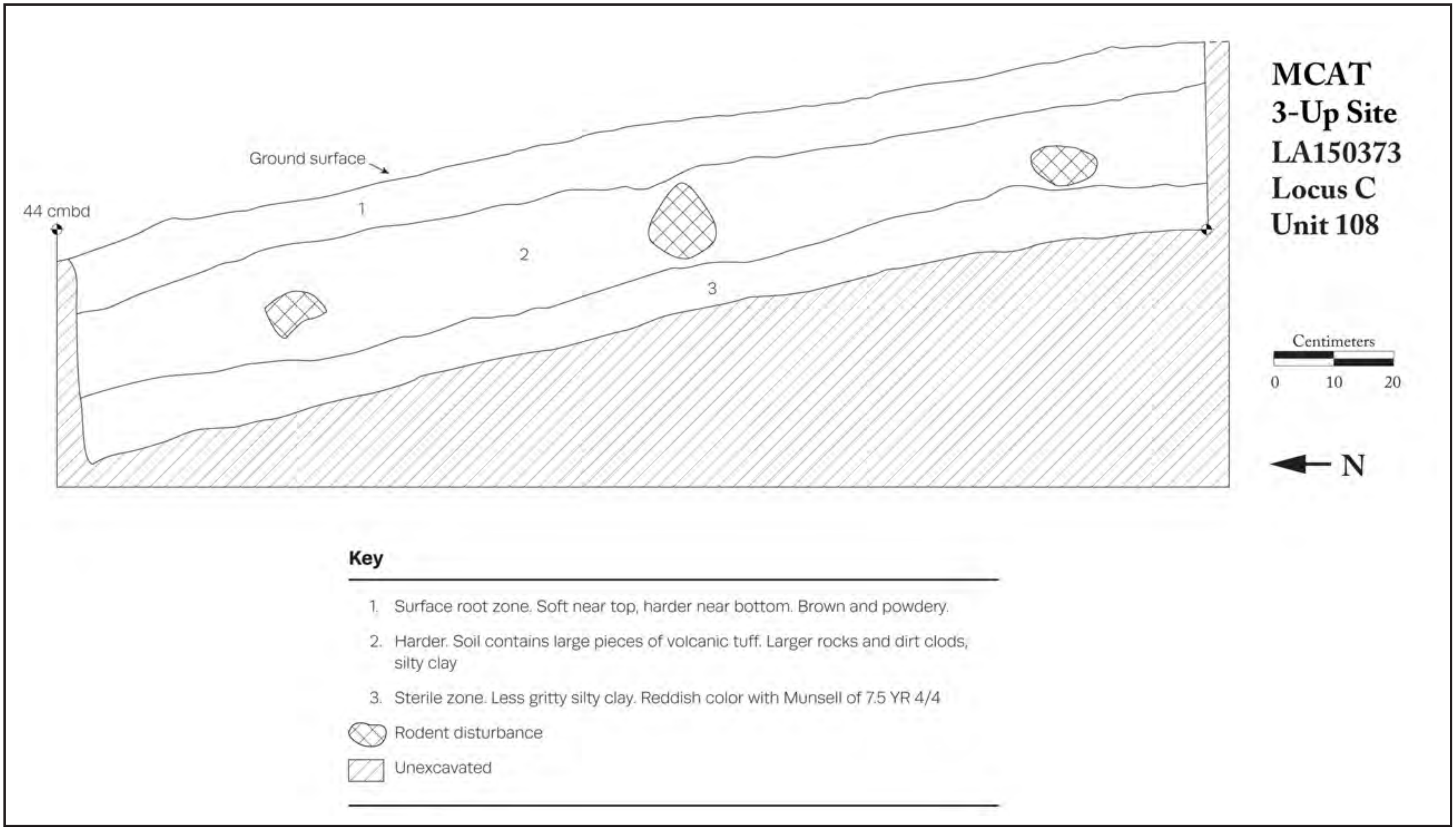

Figure 2.9. Mule Creek Archaeological Testing Project Unit 108, Locus C, south profile, the 3-Up site, LA 150373.

Unit 301 (Figure 2.10) was a 1-m by 2-m test pit excavated to a final depth of approximately 95 cmbs, at which point sterile substrate was encountered. The surface was loose gray loamy sand with 8 percent cover of low grass and sunflowers. A surface collection for the unit was collected prior to excavation of the first level. The unit was screened through ¼-inch mesh throughout.

A single 10-cm-level designated as sheet wash (Stratum 4, Level 1) was excavated. This level consisted primarily of loose, dark gray silty loam with relatively high artifact density, possibly the result of surface mobility. Ceramics in this near-surface level included Playas Red Incised, Roosevelt Red Ware, Chihuahuan polychromes, and an array of plain and corrugated ware sherds. Flaked stone (dominated by obsidian) and ground stone were also recovered, as was a single piece of possible human bone (reinterred). Root disturbance and some rodent disturbance were obvious throughout this level.

Near the base of the first 10-cm level, the deposit transitioned unevenly into dark gray silty clay loam. This was designated feature fill (Stratum 50 of Feature 10, Levels 1–7) based on high artifact density, high ash and charcoal content, and soil color. This feature fill continued with very few changes for more than 70 cm before contacting sterile substrate below. Extensive rodent disturbance was visible as areas of loose soil or voids. This layer contained approximately 20 percent subangular sand to gravel throughout, but consisted primarily of poorly compacted fines.

Artifact density remained high throughout Stratum 10. All levels contained ceramics and flaked stone, as well as ash and charcoal in varying densities. Notable artifacts from each level include the following.

(1) Level 1: Several large plain ware sherds were recovered from Level 1 and were mapped in situ. Ceramic types in this level include Salado polychromes, Playas Red Incised, and Maverick Mountain series, in addition to plain ware and corrugated ware. Animal bone and small possible human bone fragments were also recovered (the possible human fragments were reburied in the unit).

(2) Level 2: Salado polychromes and plain ware were recovered from Level 2, in addition to fire-cracked ground stone fragments, animal bone, and small possible human bone fragments (reinterred).

(3) Level 3: An increase in animal bone, charcoal, Salado polychromes, red-slipped sherds, and small, possible human bone fragments (reinterred) was noted in Level 3.

(4) Level 4: Although artifact density remained high in Level 4, a slight decrease in density was noted. The increase in animal bone noted in Level 3 continued in Level 4, as did the increase in fire-cracked rock. Excavators also noted two small fragments of possible human bone and extensive rodent disturbance.

(5) Level 5: Artifact density continued to decrease in Level 5. One small fragment of wood was taken as a dendrochronological sample from the fill of this level. A charcoal and ash smear was also visible in this level (see Figure 2.10).

(6) Level 6: Artifact density continued to decrease in Level 6, although ceramics and flake stone were still present. Artifacts of note included animal bone and a quartz crystal. An orange sandy substrate (sterile) was first detected in pockets in this level.

(7) Level 7: Level 7 was excavated to sterile, a sandy orange substrate with extensive cobbles. The gray anthropogenic soil formed an undulating contact with this substrate, which continued to contain artifacts throughout.

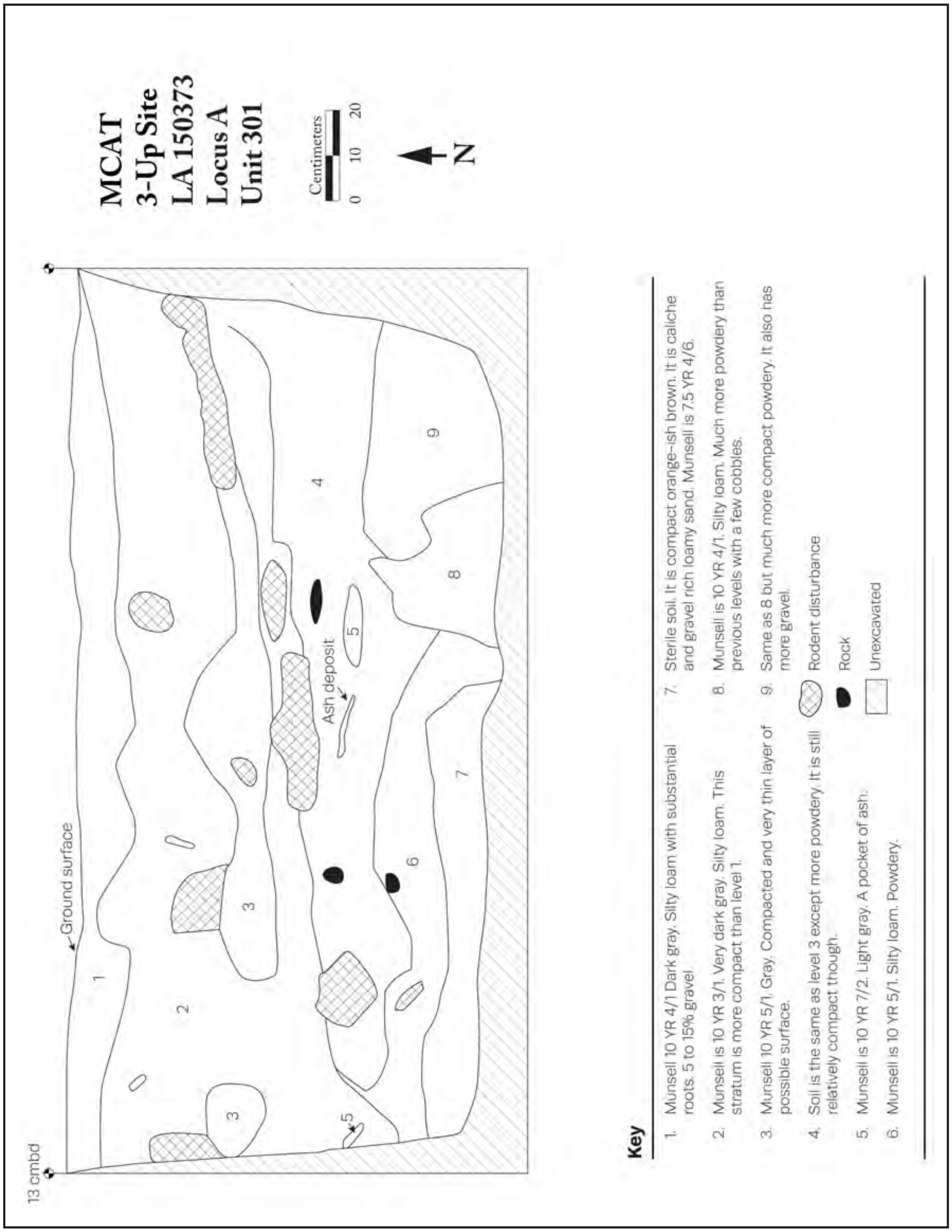

Figure 2.10. Mule Creek Archaeological Testing Project Unit 301, Locus A, north profile, the 3-Up site, LA 150373.

While the hope was to encounter architectural features in Unit 301, the deposit appears more consistent with a midden or room clean-out than with room fill, as no clear surface was encountered. The unit may have been located entirely within a room, although it was interpreted at the time as an area of sheet trash or a midden downslope from the primary occupation area.

EXCAVATION SUMMARY

Building upon previous investigations at the multicomponent 3-Up site by the Mimbres Foundation and ASU, nine 1-m by 2-m test units were excavated in 2008 and 2009.

A single unit was placed in the deeply stratified mound of Locus A, with possible midden deposits excavated to a depth of just under 1.0 m. These deposits span the entire occupation range of the 3-Up site.

Three 1-m by 2-m units were placed in Locus B, with excavations between 0.82 and 1.80 m into trash deposits associated with the adobe room block. Cultural materials in this context are largely from the thirteenth century and later.

Three 1-m by 2-m test units were excavated in Locus C. Although the intention was to sample trash deposits associated with the Cliff phase adobe room block in this locus, one unit inadvertently captured a portion of a room floor. Deposits were relatively shallow in Locus C (30–40 cm), although ASU's test unit (in a bulldozer cut farther inside the architectural area) was much deeper.

In Locus F, a single 1-m by 2-m test unit was excavated to a depth of approximately 60 cm. This unit was in trash deposits.

The single 1-m by 2-m unit in Locus G was in sheet wash, and it revealed a trash-filled pit, possibly a former storage feature. Deposits in this area were about 50 cm deep.

Given substantial bulldozer disturbance and limited excavations at 3-Up, information about construction and site layout remains incomplete. The site contains both masonry and adobe room blocks, which are often superimposed and remodeled. No obvious communal or ceremonial structures were identified during the current excavations nor during previous work. However, deep and stratified trash deposits were located. The 3-Up site was clearly occupied for a long period of time, if episodically. Moreover, distinctive ceramic types and architectural forms attest to shifting cultural affiliations of the various occupants of the area (see Chapters 3 and 9, this volume).

CHAPTER 3

CERAMIC ANALYSIS

Katherine Dungan and Deborah L. Huntley

The analyses presented here use data from three sets of ceramic artifacts from the 3-Up site, LA 150373. The first is the collection from nine units excavated during the Mule Creek Archaeological Testing Project (MCAT) in 2008 and 2009; the second is a non-systematic surface collection from Loci A, B, and C, also made during the 2008 MCAT season; and the third is the assemblage from excavations by researchers from Arizona State University (ASU) in four units in 2007 (Schollmeyer et al. 2007).

TYPOLOGY AND METHODOLOGY

MCAT ceramic artifacts were analyzed in the laboratory; decorated sherds (as used here, sherds with visible painted decoration, incised decoration, or two colors of slip) were sorted by type, while sherds without visible decoration were sorted by surface treatment and paste color. When possible, sherds were coded by vessel form (bowl vs. jar) and shape (for example, recurved bowl). Howver, as discussed here, few undecorated sherds could be sorted into these categories. All sherds larger than 4 cm^2 that were collected in the field were analyzed. ASU decorated ceramics not previously typed were reexamined in the Archaeology Southwest laboratory; otherwise, data summarized here rely on type determinations made by the ASU analysts. A list of all ceramic types recovered from either excavations or surface collections during the MCAT 2008 and 2009 seasons is given in Table 3.1. The range of types is very similar to that recovered by the ASU group. Implications for site dating are discussed later in this report.

The ceramic typology used here includes several late Salado Polychrome (or Roosevelt Red Ware) types, as described by Lyons (2004; also, Neuzil and Lyons 2006). The procedures used to assign Salado Polychrome and Maverick Mountain Series sherds to a particular type were fairly conservative. Because Gila and Cliff Polychrome can only be distinguished from one another based on rim morphology and the presence or absence of a design field at the rim (above the banding line), only diagnostic rim sherds or partial vessels were assigned to either of these types. Most of the “Undifferentiated Salado Polychrome” bowls are probably either Gila Polychrome or Cliff Polychrome.

Sherds were only typed as Tonto Polychrome if red design elements clearly interacted with black-and-white elements. Only rim sherds of bowls were typed as Dinwiddie Polychrome, as at least one clearly smudged jar rim with a Salado exterior design appears in the MCAT collection; thus, the “Undifferentiated Salado” category contains a group of smudged sherds (25 sherds, or about 10 percent of all Undifferentiated Salado), which could not be securely typed as Dinwiddie Polychrome using the standing type definition. It is highly unlikely the sherds coded as Undifferentiated Salado Polychrome include any Pinto Polychrome sherds.

Sherds were only coded as Maverick Mountain Polychrome (or Black-on-red) if hachure was visible in the design. Sherds were coded as Tucson Polychrome if the design appeared on the exterior of a bowl sherd and/or if the sherd was large enough to suggest the presence of hachure elsewhere in the design was unlikely. Due to these conservative procedures, very few sherds could be securely typed to either category. All sherds coded as Undifferentiated Maverick Mountain Series are presumably either Tucson or Maverick Mountain Polychrome. This conservative approach to Salado Polychrome and Maverick Mountain types suggests the

Table 3.1. Ceramic types and production date ranges.

Ware/Type	Date Range (AD)
Mogollon/Mimbres	
Mogollon Red-on-brown	650–750
Three Circle Red-on-white	750–800
Boldface Black-on-white	750–900/950
Mimbres Transitional Black-on-white	900–1000
Mimbres Classic Black-on-white	1000–1150
Undifferentiated Mimbres Black-on-white	750–1150
Black Mountain/Animas Phase	
Chupadero Black-on-white	1130–1500+
El Paso Polychrome	1130–1400
Playas Red Incised	1130–1400
Maverick Mountain Series	
Maverick Mountain Black-on-red	1275–1325
Maverick Mountain Polychrome	1275–1325
Prieto Polychrome	1275–1400
Tucson Polychrome	1275–1400
Undifferentiated Maverick Mountain Series	1275–1400
Roosevelt Red Ware (aka Salado Polychrome)	
Gila Polychrome	1300–1450
Tonto Polychrome	1340–1450
Cliff Polychrome	1350–1450
Dinwiddie Polychrome	1375–1450
Nine Mile Polychrome	1375–1450
Undifferentiated Salado Polychrome	1300–1450
Cliff White-on-red	1350–1450
White Mountain Red Ware	
St. Johns Black-on-red or St. Johns Polychrome	1200–1300
Heshotauthla Black-on-red or Heshotauthla Polychrome	1275–1450+
Undifferentiated White Mountain Red Ware	1200–1400
Cibola White Ware	
Pinedale Black-on-white	1270–1320
Undifferentiated Cibola Black-on-white	550–1325
Other Identifiable Types	
Dos Cabezas Red-on-brown	650–800
San Carlos Red-on-brown	1250–1450
Undifferentiated Rio Grande Glaze Ware	Post-1300
Salado Red	1150–1400
Undifferentiated Categories for Decorated Ceramics (no reliable dates)	
Undifferentiated Brown Ware	–
Undifferentiated Polychrome	–
Undifferentiated Red Ware	–
Undifferentiated White Ware	–
Undifferentiated White-on-red	–

current data may not be directly comparable, by type, to the ASU ceramic data. Thus, the comparison below relies on wares, series, or aggregations of types that should be consistent between the two analyses.

A final note about the typology concerns Cliff White-on-red and the large collection of sherds (n = 40) coded here as "Undifferentiated White-on-red." The label "Cliff White-on-red" was first used for smudged, white-on-red bowls found in late sites in the Upper Gila area by Jack and Vera Mills in their description of material from the Dinwiddie site (Mills and Mills 1972). Neuzil and Lyons (2006:32) classify Cliff White-on-red as a Roosevelt Red Ware and describe the type as including smudged, recurved bowls decorated with thick-lined, solid or negative designs, including a banding line. They suggest the distribution of the type was restricted to southwestern New Mexico and southeastern Arizona.

Cliff White-on-red is similar to Tularosa White-on-red, which is distinguished by the presence of Tularosa Fillet Rim style corrugation at the rim, the lack of a banding line, and by the use of thinner lines in exterior decoration. Tularosa White-on-red was produced at Tularosa phase sites in the eastern Mogollon Highlands of west-central New Mexico and east-central Arizona, although the type tends to be comparatively rare even at most of these sites. Given the presence of Tularosa or Black Mountain phase deposits in Mule Creek, both types could plausibly be found at the 3-Up site. Therefore, in this analysis of the MCAT material, only rim sherds or near rim sherds that clearly showed a lack of fillet rim characteristics were coded as Cliff White-on-red.

Nearly all the sherds coded as Undifferentiated White-on-red were smudged. The ASU collection contains several sherds coded as Tularosa White-on-red; because none of these sherds were rims, they would have been coded as Undifferentiated White-on-red here. In the comparison of types by locus incorporating data from both projects, Cliff White-on-red, Tularosa White-on-red, and Undifferentiated White-on-red are lumped into a single category.

RECONSTRUCTIBLE PARTIAL VESSELS

Six groups of sherds recovered from MCAT excavation units were assigned vessel numbers. Four of these were recovered from the room floor or directly above the room floor (Feature 7) in Unit 106; the remaining two were recovered from the lower levels of Unit 103. All but one of these vessels are Salado polychromes.

Vessel 1, recovered from above the room floor (Field Number [FN] 161 and FN 250), is a jar with a Tonto Polychrome exterior design (Figure 3.1). The vessel is unusual in that there is a consistent gap, showing perhaps 1–3 mm of unslipped surface, between the red and white slips. Both slip colors appear to be very thick and well polished, and the red slip seems particularly dark. The vessel interior is partially smudged. As with several of the partial vessels, the recovered portions are several sizable sherds, most of which cannot be refitted. No vessel rim was recovered. Due to the interior smudging, jar form, and somewhat odd design, this vessel was not assigned a type.

Figure 3.1. Vessel 1, a partial Tonto Polychrome jar from above the room floor in Feature 7, Unit 106, Locus C, the 3-Up site, LA 150373.

Vessel 2 (Figure 3.2) appears to have been a semi-flaring or recurved Dinwiddie Polychrome bowl (it is a smudged bowl with a Tonto Polychrome exterior design). Large pieces of this vessel (FNs 161, 250, and 254) were recovered on or above the floor of Feature 7. The vessel has an estimated rim diameter of 39 cm and an estimated height of 9 to 10 cm—the sherds were large enough that a rough estimate of vessel height could be obtained by measuring the height of the sherd—with the recovered portion representing less than 15 percent of the entire vessel. While the odd gap between slip colors from Vessel 1 is not present, the thick, dark red slip on this vessel is very similar to that of Vessel 1.

Figure 3.2. Vessel 2, a partial Dinwiddie Polychrome bowl from on or just above the room floor in Feature 7, Unit 106, Locus C, the 3-Up site, LA 150373.

Vessel 3 (Figure 3.3) consists of several fragments of a Tonto Polychrome jar (FN 161) recovered from above the room floor. As with Vessel 1, only a few sherds could be refitted, and no rim sherds were recovered. Unlike Vessels 1 and 2, however, the interior of Vessel 3 is not smudged. The red slip is much brighter than that of Vessels 1 and 2; both red and white slips appear thinner and washier (subjectively, this seems typical of Salado sherds at the site), and they usually meet without leaving a gap. The design seems to be somewhat poorly executed, with several apparent overrunning lines, gaps, or blobs of paint.

Figure 3.3. Vessel 3, a partial Tonto Polychrome jar from above the room floor in Feature 7, Unit 106, Locus C, the 3-Up site, LA 150373.

Vessel 4 (Figure 3.4) is a perforated plate (see Lyons and Lindsay 2006 for an extended discussion of this artifact type). The plate was recovered from the room floor (it was assigned a unique FN of 267) at the edge of Unit 106, and it is very likely that more of this object is outside the excavated area. The plate is a sand-tempered brown ware (a cursory examination shows it to be generally consistent with typical brown ceramics found at the site) with a single row of perforations approximately 1 cm from the edge of the plate and spaced at intervals of approximately 2 cm. The entire vessel is estimated to have had a diameter of 44 cm, with the recovered sherds together representing perhaps 15 percent of the vessel. The surfaces of the plate are not par-

Figure 3.4. Vessel 4, a partial perforated plate from the room floor in Feature 7, Unit 106, Locus C, the 3-Up site, LA 150373.

ticularly well preserved, but at least one side appears to have been well polished. A portion of the other side appears to have fire-clouding or sooting.

A final vessel from Unit 106 was not assigned a unique vessel number. Several very large polished, smudged brown ware sherds (the largest is approximately 10 cm by 15 cm) appear in the same contexts as the decorated partial vessels. Most or all of these sherds are likely from a single vessel (given the size of the largest sherds, probably a jar). In the modest amount of time allocated to searching for refits, however, too few refitting sherds were found to provide an impression of the overall vessel shape and to justify the assignment of a vessel number.

The association of the partial vessels with the floor or the collapsed ceiling of Feature 7 suggests that these vessels were associated with the final use of the room. The comparative incompleteness of the vessel parts indicates the remaining portions are in the unexcavated area of the room or these were broken vessels curated for possible future use left behind during abandonment of the site. An alternative hypothesis is that these vessel fragments were discarded in the room while the site, but not the room, was still in use, and that the vessels are less fragmentary and scattered than those in the trash concentrations due to their comparatively protected location in the room. Given the comparatively small number of partial vessels that comprise nearly the entire ceramic assemblage from those levels, however, this seems unlikely to have been the case.

Figure 3.5. Vessel 5, fragments of a Gila Polychrome bowl from Unit 103, Locus B, the 3-Up site, LA 150373.

The two vessel fragments from Unit 103 that were assigned vessel numbers are both Salado polychromes recovered from the lower levels of the unit below the fallen masonry wall. The first of these, Vessel 5 (Figure 3.5), is a small piece of a Gila Polychrome bowl. Estimated rim diameter is 35 cm, with an estimated vessel height of 10 cm; the recovered fragment probably represents less than 5 percent of the vessel. Unlike most of the Salado Polychrome bowl rim sherds recovered from the site, this vessel is hemispherical or slightly incurved rather than semi-flared or recurved.

Figure 3.6. Vessel 6, fragments of a Tonto Polychrome jar from Unit 103, Locus B, the 3-Up site, LA 150373.

Vessel 6 (Figure 3.6) represents a Tonto Polychrome jar; the size of the extant rim relative to the rest of the recovered sherds makes estimating the rim diameter difficult, although the vessel appears to have been a moderately large (with a maximum diameter of approximately 35 cm), relatively squat, globular jar with a flared rim.

VESSEL FORM

It was difficult to definitively identify vessel form for most of the sherds in the 3-Up site assemblage, particularly utility ware sherds. This is largely due to the continuum between recurved/semi-flaring rim bowls and wide mouth jars that characterizes late ceramic assemblages from this area. For the collection of whole vessels from Ormand Village, a roughly contemporaneous site located near Cliff, New Mexico, investigators noted that "curves and basic profiles of most jars and bowls were remarkably similar despite form differences" (Wilson 1998:197). Vessels in the Ormand collection were classified as bowls or jars based on ratios of rim diameter to vessel height, not an option in the classification of most sherds. Smudging appeared on both bowls and wide-mouthed jars at the Ormand site (Wilson 1998:Figures 106–107), making it difficult to associate this treatment with a particular vessel form.

For the MCAT assemblage, 79–92 percent of undecorated sherds (varying among units) could not be securely assigned to a particular vessel form. Decorated sherds were much more likely to be assigned to a vessel form, although erring on the side of caution, 10–45 percent of decorated sherds (varying among units) were coded as indeterminate in form. Indeterminate form decorated sherds were sometimes very small or poorly preserved; a large proportion have smudged interiors (based on the undecorated vessels at Ormand and the presence of at least one decorated smudged jar rim in the MCAT collection, such sherds could be either bowls or jars, although they are more likely to have been the former).

The high proportion of indeterminate form sherds prohibits meaningful comparison of bowl to jar ratios within or among units. The clearest pattern comes from Unit 301, the 2009 unit in Locus A, in which only 8 percent of decorated sherds could not be assigned to a vessel form, 61 percent were assigned as bowls, and 31 percent were determined to be jars. This pattern is at least partially accounted for by the large proportion of Mimbres Black-on-white sherds in the assemblage from this unit.

INTRASITE COMPARISONS

For each MCAT unit and for the surface collections, counts of decorated sherds by type and undecorated sherds by exterior and interior surface treatment are provided in Tables 3.2–3.5. Note that two of the eight units, Units 102 and 108, produced only very small collections of decorated sherds (three and nine sherds, respectively); these units are not included here in the comparison of decorated types by locus. The use of a data set including both MCAT and ASU data for a comparison among loci requires caution. As mentioned, the comparison here uses wares, series, or aggregations of types to standardize the use of specific types between the two analyses.

Further, the context of the units from each season of excavation is somewhat different. Many ASU units were placed at the edges of large cuts made sometime in the past by heavy machinery, with the excavated volume changing with the slope of the cut. In Locus A and Locus B, these units cut through structure interiors, including floors; the context in Locus C was less clear, although the excavators noted possible floors or prepared surfaces. MCAT units, in contrast, were intended to provide a controlled sample from extramural trash concentrations (with variable success, see unit descriptions above).

Even given these caveats, certain strong patterns in the distribution of decorated and undecorated ceramics among loci are apparent. The first of these is the overwhelming prevalence of Salado polychromes (and corresponding low diversity of decorated types) at Locus C compared with any other loci at the site (Figure 3.7). This pattern is true for any combination of the Locus C units (including or excluding Unit 106 or the ASU unit), as well as for the surface collection (Figure 3.8).

Table 3.2. Decorated ceramic types, by unit (count and percent unit assemblage), at the 3-Up site, LA 150373.

	Locus A		Locus B						Locus C						Locus F		Locus G			
	Unit 301		Unit 103		Unit 104		Unit 105		Unit 106		Unit 107		Unit 108		Unit 101		Unit 102		Total	
Ceramic Type	Count	Percent	Count	Percent	Count	Percent	Count	Percent	Count	Percent	Count	Percent	Count	Percent	Count	Percent	Count	Percent	Count	Percent
Maverick Mountain Black-on-red	1	0.8	–	–	–	–	–	–	1	2.9	–	–	–	–	–	–	–	–	2	0.5
Maverick Mountain Polychrome	–	–	–	–	2	3.6	4	5.6	–	–	–	–	–	–	–	–	–	–	6	1.4
Prieto Polychrome	1	0.8	2	8.7	–	–	1	1.4	–	–	–	–	–	–	–	–	–	–	4	0.9
Tucson Polychrome	1	0.8	–	–	2	3.6	4	5.6	–	–	–	–	–	–	–	–	–	–	7	1.6
Undifferentiated Maverick Mountain Series	2	1.6	2	8.7	11	20.0	12	16.9	1	2.9	–	–	–	–	5	10.4	–	–	33	7.8
Total Maverick Mountain Series	*5*	*4.0*	*4*	*17.4*	*15*	*27.3*	*21*	*29.6*	*2*	*5.7*	–	–	–	–	*5*	*10.4*	–	–	*52*	*12.2*
Gila Polychrome	1	0.8	2	8.7	–	–	–	–	–	–	–	–	–	–	–	–	–	–	3	0.7
Tonto Polychrome	–	–	1	4.3	–	–	–	–	6	17.1	1	1.8	–	–	–	–	–	–	8	1.9
Cliff Polychrome	–	–	–	–	1	1.8	–	–	1	2.9	3	5.3	–	–	1	2.1	–	–	6	1.4
Dinwiddie Polychrome	–	–	–	–	–	–	–	–	1	2.9	–	–	–	–	–	–	–	–	1	0.2
Nine Mile Polychrome	–	–	–	–	–	–	–	–	1	2.9	–	–	–	–	–	–	–	–	1	0.2
Undifferentiated Salado Polychrome	35	28.2	11	47.8	14	25.5	14	19.7	18	51.4	52	91.2	9	100.0	27	56.3	2	66.7	182	42.8
Total Salado Polychrome	*36*	*29.0*	*14*	*60.9*	*15*	*27.3*	*14*	*19.7*	*27*	*77.1*	*56*	*98.2*	*9*	*100.0*	*28*	*58.3*	*2*	*66.7*	*201*	*47.3*
Cliff White-on-red	1	0.8	–	–	–	–	2	2.8	1	2.9	–	–	–	–	1	2.1	–	–	5	1.2
Undifferentiated White-on-red	4	3.2	3	13.0	18	32.7	16	22.5	–	–	1	1.8	–	–	2	4.2	–	–	44	10.4
Total White-on-red	*5*	*4.0*	*3*	*13.0*	*18*	*32.7*	*18*	*25.4*	*1*	*2.9*	*1*	*1.8*	–	–	*3*	*6.3*	–	–	*49*	*11.5*
Mogollon Red-on-brown	5	4.0	–	–	–	–	–	–	–	–	–	–	–	–	1	2.1	–	–	6	1.4
Three Circle Red-on-brown	5	4.0	–	–	–	–	1	1.4	–	–	–	–	–	–	–	–	–	–	6	1.4
Mimbres Boldface Black-on-white	5	4.0	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	5	1.2
Mimbres Transitional Black-on-white	5	4.0	–	–	1	1.8	–	–	–	–	–	–	–	–	–	–	–	–	6	1.4
Mimbres Classic Black-on-white	6	4.8	1	4.3	–	–	1	1.4	–	–	–	–	–	–	–	–	–	–	8	1.9
Undifferentiated Mimbres Black-on-white	25	20.2	–	–	3	5.5	9	12.7	–	–	–	–	–	–	3	6.3	1	33.3	41	9.6
Total Mogollon/Mimbres	*51*	*41.1*	*1*	*4.3*	*4*	*7.3*	*11*	*15.5*	–	–	–	–	–	–	*4*	*8.3*	*1*	*33.3*	*72*	*16.9*
St. Johns Black-on-red or Polychrome	2	1.6	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	2	0.5
Undifferentiated White Mountain Red Ware	–	–	–	–	2	3.6	–	–	–	–	–	–	–	–	–	–	–	–	2	0.5
Undifferentiated Cibola White Ware	2	1.6	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	2	0.5
Pinedale Black-on-white	–	–	–	–	1	1.8	–	–	–	–	–	–	–	–	–	–	–	–	1	0.2
Chupadero Black-on-white	1	0.8	–	–	–	–	–	–	–	–	–	–	–	–	1	2.1	–	–	2	0.5
El Paso Polychrome	3	2.4	–	–	–	–	–	–	4	11.4	–	–	–	–	–	–	–	–	7	1.6
Playas Red	4	3.2	1	4.3	–	–	1	1.4	–	–	–	–	–	–	–	–	–	–	6	1.4
Salado Red	–	–	–	–	–	–	1	1.4	–	–	–	–	–	–	–	–	–	–	1	0.2
Undifferentiated Rio Grande Glaze Ware	1	0.8	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	1	0.2
San Carlos Red-on-brown	1	0.8	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	1	0.2
Total Other Types	*14*	*11.3*	*1*	*4.3*	*3*	*5.5*	*2*	*2.8*	*4*	*11.4*	–	–	–	–	*1*	*2.1*	–	–	*25*	*5.9*
Undifferentiated Brown Ware	3	2.4	–	–	–	–	2	2.8	1	2.9	–	–	–	–	–	–	–	–	6	1.4
Undifferentiated Polychrome	–	–	–	–	–	–	1	1.4	–	–	–	–	–	–	2	4.2	–	–	3	0.7
Undifferentiated Red Ware	1	0.8	–	–	–	–	–	–	–	–	–	–	–	–	4	8.3	–	–	5	1.2
Undifferentiated White Ware	9	7.3	–	–	–	–	2	2.8	–	–	–	–	–	–	1	2.1	–	–	12	2.8
Total Undifferentiated	*13*	*10.5*	–	–	–	–	*5*	*7.0*	*1*	*2.9*	–	–			*7*	*14.6*	–	–	*26*	*6.1*
Grand Total	124	100.0	23	100.0	55	100.0	71	100.0	35	100.0	57	100.0	9	100.0	48	100.0	3	100.0	425	100.0

Table 3.3. Decorated ceramic surface collections, by locus, at the 3-Up site, LA 150373.

	Locus A		Locus B		Locus C		Total	
	n	%	*n*	%	*n*	%	*n*	%
Maverick Mountain Black-on-red	6	3.5	–	–	–	–	6	2.3
Maverick Mountain Polychrome	5	2.9	1	2.3	1	2.3	7	2.7
Prieto Polychrome	1	0.6	–	–	–	–	1	0.4
Tucson Polychrome	2	1.2	8	18.6	–	–	10	3.9
Undifferentiated Maverick Mountain Series	10	5.9	1	2.3	1	2.3	12	4.7
Maverick Mountain Series	*24*	*14.1*	*10*	*23.3*	*2*	*4.5*	*36*	*14.0*
Gila Polychrome	3	1.8	3	7.0	–	–	6	2.3
Tonto Polychrome	3	1.8	–	–	2	4.5	5	1.9
Cliff Polychrome	3	1.8	5	11.6	6	13.6	14	5.4
Nine Mile Polychrome	–	–	–	–	1	2.3	1	0.4
Undifferentiated Salado Polychrome	49	28.8	16	37.2	30	68.2	95	37.0
Salado Polychrome	*58*	*34.1*	*24*	*55.8*	*39*	*88.6*	*121*	*47.1*
Cliff White-on-red	2	1.2	–	–	–	–	2	0.8
Undifferentiated White-on-red	8	4.7	4	9.3	–	–	12	4.7
Undifferentiated White-on-red	*10*	*5.9*	*4*	*9.3*	–	–	*14*	*5.4*
Three Circle Red-on-white	6	3.5	1	2.3	–	–	7	2.7
Mogollon Red-on-brown	1	0.6	–	–	–	–	1	0.4
Boldface Black-on-white	5	2.9	–	–	–	–	5	1.9
Mimbres Transitional Black-on-white	14	8.2	–	–	–	–	14	5.4
Mimbres Classic Black-on-white	7	4.1	–	–	–	–	7	2.7
Undifferentiated Mimbres Black-on-white	9	5.3	1	2.3	–	–	10	3.9
Mogollon/Mimbres Types	*42*	*24.7*	*2*	*4.7*	–	–	*44*	*17.1*
Pinedale Black-on-white	1	0.6	–	–	–	–	1	0.4
Undifferentiated Cibola Black-on-white	4	2.4	–	–	1	2.3	5	1.9
Cibola White Ware	*5*	*2.9*	–	–	*1*	*2.3*	*6*	*2.3*
St. Johns Black-on-red or Polychrome	5	2.9	–	–	–	–	5	1.9
Heshotauthla Black-on-red or Polychrome	3	1.8	1	2.3	–	–	4	1.6
Undifferentiated White Mountain Red Ware	7	4.1	1	2.3	–	–	8	3.1
White Mountain Red Ware	*15*	*8.8*	*2*	*4.7*	–	–	*17*	*6.6*
Chupadero Black-on-white	4	2.4	–	–	–	–	4	1.6
El Paso Polychrome	4	2.4	–	–	–	–	4	1.6
Playas Red	4	2.4	1	2.3	–	–	5	1.9
South New Mexico Types	*12*	*7.1*	*1*	*2.3*	–	–	*13*	*5.1*
Dos Cabezas Red-on-brown	1	0.6	–	–	–	–	1	0.4
Undifferentiated Brown Ware	1	0.6	–	–	–	–	1	0.4
Undifferentiated Red Ware	–	–	–	–	2	4.5	2	0.8
Undifferentiated White Ware	2	1.2	–	–	–	–	2	0.8
Other/Undifferentiated	*4*	*2.4*	–	–	*2*	*4.5*	*6*	*2.3*
Total	170	100.0	43	100.0	44	100.0	257	100.0

Locus B has, by far, the most substantial Maverick Mountain series presence, a trend common to all units and the surface collection. Locus B also has the highest incidence of white-on-red; the concentration of these white-on-red sherds at a locus generally characterized by high proportions of Maverick Mountain series sherds and not at the locus (Locus C) characterized by high proportions of Salado polychrome types is worth further exploration.

Table 3.4. Unpainted ceramics, by unit, from the 3-Up site, LA 150373.

	Smudged	Not Smudged	Indeterminate Interior
Locus A, Unit 301			
Non-corrugated Brown Ware	160	274	45
Non-corrugated Red Slipped	32	65	7
Smudged, burned, or eroded exterior	12	13	12
Gray Ware	–	–	–
Alma Plain	–	1	–
Other unidentified non-local type	–	–	–
Corrugated Brown Ware	90	195	–
Corrugated Red Slipped	8	11	–
Tularosa Fillet Rim	3	–	–
Smudged, burned, or eroded corrugated exterior	6	9	1
Totals	*944*		
Locus F, Unit 101			
Non-corrugated Brown Ware	166	36	5
Non-corrugated Red Slipped	58	15	1
Smudged, burned, or eroded exterior	5	–	–
Gray Ware	–	1	–
Alma Plain	–	–	–
Other unidentified non-local type	–	–	–
Corrugated Brown Ware	17	11	–
Corrugated Red Slipped	2	6	–
Tularosa Fillet Rim	–	–	–
Smudged, burned, or eroded corrugated exterior	1	–	–
Totals	*324*		
Locus G, Unit 102			
Non-corrugated Brown Ware	15	45	6
Non-corrugated Red Slipped	3	23	–
Smudged, burned, or eroded exterior	1	2	–
Gray Ware	–	–	–
Alma Plain	–	–	–
Other unidentified non-local type	–	–	–
Corrugated Brown Ware	2	–	4
Corrugated Red Slipped	–	–	–
Tularosa Fillet Rim	–	–	–
Smudged, burned, or eroded corrugated exterior	–	–	–
Totals	*101*		
Locus B, Unit 103			
Non-corrugated Brown Ware	62	48	8
Non-corrugated Red Slipped	29	53	6
Smudged, burned, or eroded exterior	4	1	2
Gray Ware	–	–	–

Table 3.4. Continued.

	Smudged	Not Smudged	Indeterminate Interior
Locus B, Unit 103 (continued)			
Alma Plain	–	–	–
Other unidentified non-local type	–	–	–
Corrugated Brown Ware	22	29	3
Corrugated Red Slipped	7	7	–
Tularosa Fillet Rim	–	–	–
Smudged, burned, or eroded corrugated exterior	–	2	–
Totals	*283*		
Locus B, Unit 104			
Non-corrugated Brown Ware	81	54	9
Non-corrugated Red Slipped	52	39	5
Smudged, burned, or eroded exterior	7	6	–
Gray Ware	–	–	–
Alma Plain	–	–	–
Other unidentified non-local type	–	–	–
Corrugated Brown Ware	75	52	–
Corrugated Red Slipped	28	12	–
Tularosa Fillet Rim	–	–	–
Smudged, burned, or eroded corrugated exterior	5	2	3
Totals	*430*		
Locus B, Unit 105			
Non-corrugated Brown Ware	116	110	29
Non-corrugated Red Slipped	127	142	13
Smudged, burned, or eroded exterior	30	10	12
Gray Ware	–	–	–
Alma Plain	–	–	–
Other unidentified non-local type	–	1	–
Corrugated Brown Ware	109	149	23
Corrugated Red Slipped	87	91	25
Tularosa Fillet Rim	8	–	–
Smudged, burned, or eroded corrugated exterior	38	12	2
Totals	*1,134*		
Locus C, Unit 106			
Non-corrugated Brown Ware	147	35	6
Non-corrugated Red Slipped	11	22	–
Smudged, burned, or eroded exterior	1	1	1
Gray Ware	–	–	–
Alma Plain	–	1	–
Other unidentified non-local type	–	–	–
Corrugated Brown Ware	4	8	–
Corrugated Red Slipped	10	9	–
Tularosa Fillet Rim	–	–	–

Table 3.4. Continued.

	Smudged	Not Smudged	Indeterminate Interior
Locus C, Unit 106 (continued)			
Smudged, burned, or eroded corrugated exterior	–	–	–
Totals	*256*		
Locus C, Unit 107			
Non-corrugated Brown Ware	203	46	8
Non-corrugated Red Slipped	37	47	5
Smudged, burned, or eroded exterior	14	1	3
Gray Ware	–	–	–
Alma Plain	–	–	–
Other unidentified non-local type	–	–	–
Corrugated Brown Ware	17	3	1
Corrugated Red Slipped	2	1	–
Tularosa Fillet Rim	–	–	–
Smudged, burned, or eroded corrugated exterior	–	–	–
Totals	*388*		
Locus C, Unit 108			
Non-corrugated Brown Ware	24	27	27
Non-corrugated Red Slipped	1	7	2
Smudged, burned, or eroded exterior	1	1	2
Gray Ware	–	1	–
Alma Plain	–	–	–
Other unidentified non-local type	–	–	–
Corrugated Brown Ware	1	–	–
Corrugated Red Slipped	–	–	–
Tularosa Fillet Rim	–	–	–
Smudged, burned, or eroded corrugated exterior	–	–	–
Totals	*94*		

The Locus A excavations, including both the ASU and MCAT units, have a high proportion of Mogollon or Mimbres ceramics; the entire sequence of Mogollon/Mimbres ceramics, beginning with Mogollon Red-on-brown, is represented, although most of the sherds were Mimbres Black-on-white sherds that could not be identified to a particular subtype. The Locus A units and surface collections also have a somewhat higher diversity of types compared with other loci (including a small amount of diagnostic thirteenth century nonlocal types; see temporal discussion below); this could, however, be an artifact of the larger sample size.

The final pattern involves the distribution of corrugated ceramics among loci. Although a comparison of the MCAT and ASU data on undecorated ceramics has not yet been completed, the MCAT units show a clear difference in the proportion of corrugated ceramics between Loci A and B and Locus C. Between 25 and 48 percent of undecorated sherds from Locus B units and approximately 34 percent of the undecorated sherds from the Locus A units have corrugated surface treatments. In contrast, the undecorated sherds from Locus C units range between 1 and 12 percent corrugated, with the room floor (Unit 106) showing the highest proportion (Figure 3.9).

Comparing only those contexts that can be securely interpreted as trash concentrations gives a total of approximately 34 percent for Locus A, 46 percent for Locus B (combined Units 104 and 105), and 6 percent (Unit 107) for Locus C (Figure 3.10). This pattern is presumably a product of the temporal differences already visible in the decorated ceramics. A more detailed comparison of the corrugated surface treatments at Loci A and B would likely help clarify the thirteenth century component of the site, as thirteenth century diagnostic decorated sherds apparently occur in only very small proportions in sites in this region.

CERAMIC COMPOSITIONAL ANALYSIS

As part of a larger study of ceramic production and distribution in southwestern New Mexico and southeastern Arizona (Huntley et al. 2016; Ownby 2012; Ownby et al. 2014), the University of Missouri Research Reactor (MURR) conducted Neutron Activation Analysis (NAA) on 79 Maverick Mountain series (n = 21), Salado Polychrome (n = 33), and utility ware (n = 25, including a perforated plate fragment) sherds from the 3-Up site. Of these, 48 percent (n = 38) are chemically similar and comprise a compositional group attributed here to local production at the 3-Up site. Nearly all the sampled utility ware sherds, as well as the perforated plate, are in this group. Maverick Mountain series and Salado Polychrome sherds are spread among several

Table 3.5. Bowl and jar frequencies, by ware, at the 3-Up site, LA 150373.

	Decorated	Brown Ware	Red Ware	Other Plain
Unit 301				
Bowl	76	9	10	–
Jar	38	58	23	–
Indeterminate	10	751	92	1
Other	–	1	–	–
Total	124	819	125	1
Unit 101				
Bowl	18	1	1	–
Jar	19	14	6	–
Indeterminate	11	226	76	1
Other	–	–	–	–
Total	48	241	83	1
Unit 102				
Bowl	1	4	2	–
Jar	2	7	7	–
Indeterminate	–	64	17	–
Other	–	–	–	–
Total	3	75	26	–
Unit 103				
Bowl	14	1	11	–
Jar	4	24	21	–
Indeterminate	5	154	69	–
Other	–	2	1	–
Total	23	181	102	–
Unit 104				
Bowl	13	2	4	–
Jar	17	18	24	–
Indeterminate	25	272	109	–
Other	–	1	–	–
Total	55	293	137	–

Table 3.5. Continued.

	Decorated	Brown Ware	Red Ware	Other Plain
Unit 105				
Bowl	16	1	18	3
Jar	26	21	74	–
Indeterminate	29	617	394	6
Other	–	–	–	–
Total	71	639	486	9
Unit 106				
Bowl	11	–	3	–
Jar	20	6	9	–
Indeterminate	4	194	40	1
Other	–	1	–	–
Total	35	201	52	1
Unit 107				
Bowl	15	9	5	–
Jar	36	9	29	–
Indeterminate	6	276	59	–
Other	–	1	–	–
Total	57	295	93	–
Unit 108				
Bowl	2	3	3	–
Jar	3	6	5	–
Indeterminate	4	73	3	1
Other	–	–	–	–
Total	9	82	11	1

compositional groups, but are most common in the local 3-Up group and another group that contains only decorated ware.

The source for this group of chemically similar decorated wares cannot be pinpointed, although the interpretation presented here is that this and three other groups made up only of decorated ware represent regional compositional similarity in particular clays and tempers selected for decorated ware only. This hypothesis is supported by petrographic analysis, which shows that decorated ware sherds in the current sample tend to have finer sand grains compared to utility ware. These four decorated groups may also indicate widespread exchange among several production areas, and they may include as yet unsampled sources for Salado polychromes imported throughout the Upper Gila and Mimbres regions.

Petrographic analysis of a subset of the NAA sample from the 3-Up site (n = 3) highlights additional trends in ceramics from the site. The 3-Up site is located within Middle Pleistocene to uppermost Oligocene Gila Group deposits (mostly conglomerate, sandstone, and basalt); however, sand along Mule Creek should be composed of Middle Pleistocene to uppermost Oligocene volcanic rocks (mostly rhyolite and andesite, some basalt, pyroclastic and mafic rocks) from the mountains to the southwest. Indeed, sand tempers in a Cliff Polychrome and a Tucson Polychrome from 3-Up are petrographically similar, containing fine volcanic sand with rhyolitic tuff, basalt, and some andesite consistent with the local geology. These samples are also chemically similar. While the perforated plate from the 3-Up site is chemically distinctive, its volcanic sand temper contains similar inclusions to the polychrome samples—only the grain sizes are larger. The clay matrix is visually similar as well.

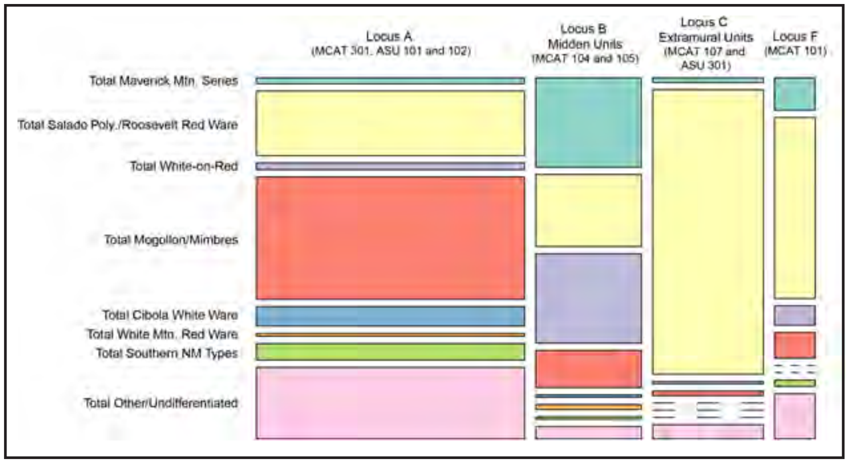

Figure 3.7. Excavation units decorated ceramics, by locus (Mule Creek Archaeological Testing Project and Arizona State University), the 3-Up site, LA 150373.

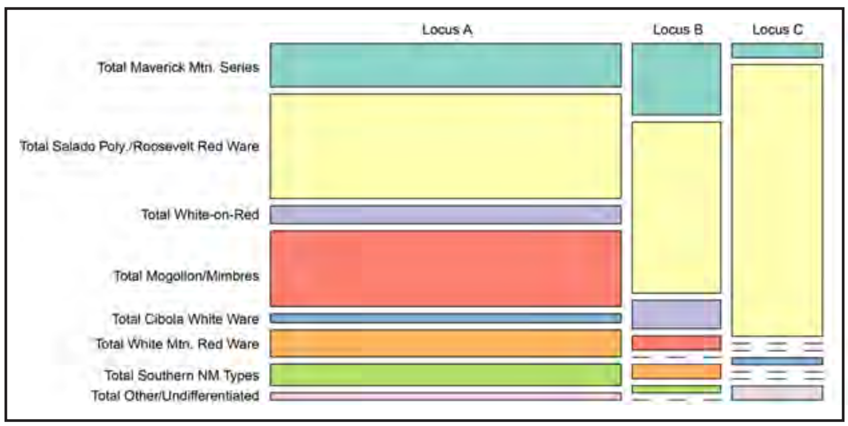

Figure 3.8. Mule Creek Archaeological Testing Project surface collection decorated ceramics, the 3-Up site, LA 150373.

Overall, it is concluded here that some polychrome vessels may have been produced locally at several Upper Gila sites, while others are more likely to be imports. The 3-Up site, in addition to Ormand Village in the Cliff Valley, likely produced polychrome pottery and imported it to other contemporaneous villages in southwestern New Mexico and southeastern Arizona. Some of this pottery may have reached the Mimbres River Valley, where there is little evidence for local polychrome pottery production.

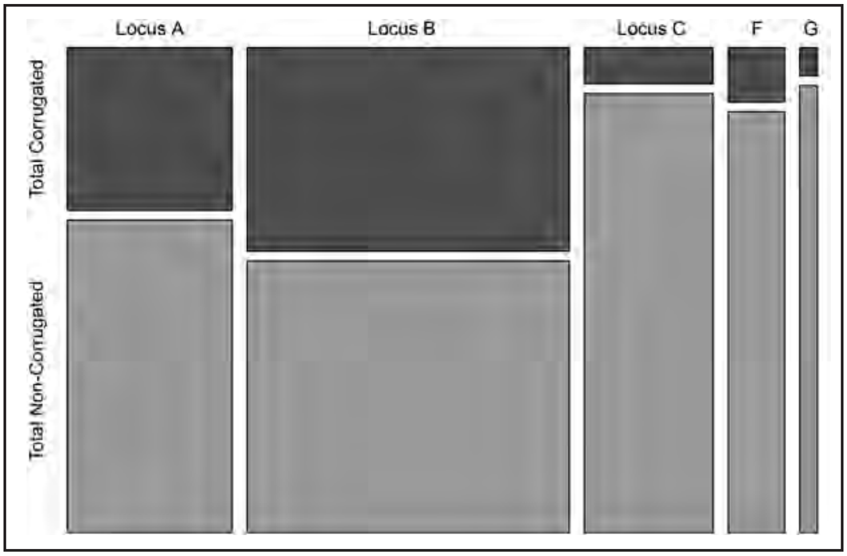

Figure 3.9. Corrugated and non-corrugated ceramics, by locus, Mule Creek Archaeological Testing Project collections, the 3-Up site, LA 150373.

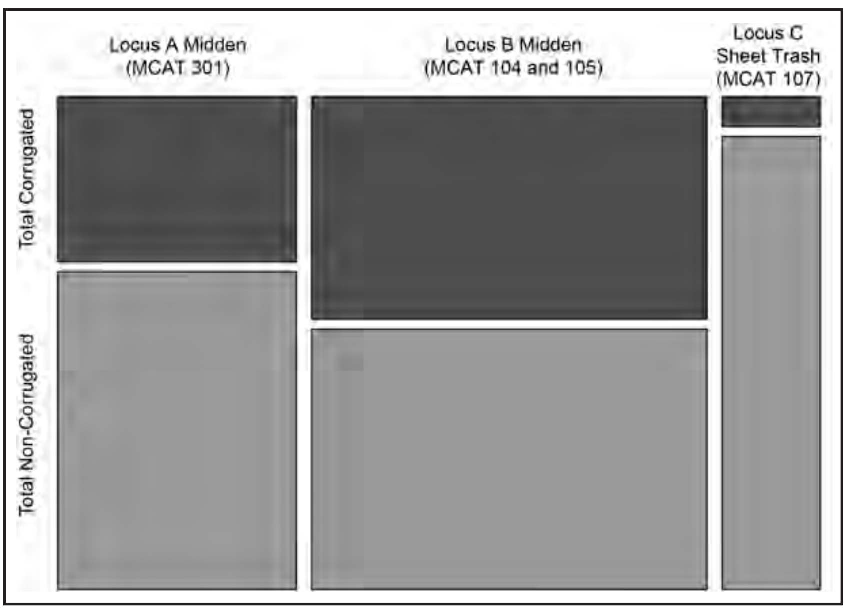

Figure 3.10. Proportions of corrugated ceramics from trash deposits, by locus, Mule Creek Archaeological Testing Project collections, the 3-Up site, LA 150373.

CHAPTER 4

FLAKED STONE TECHNOLOGY

Stacy L. Ryan

Excavations during two field seasons at the 3-Up site, LA 150373, resulted in the recovery of more than 5,000 flaked stone artifacts. The results of analysis of a sample of 1,322 artifacts recovered from three loci occupied during the Late Pueblo period (AD 1000–1450) are presented here.

RESEARCH QUESTIONS

Occupants of the 3-Up site seem to have had unlimited access to an abundance of obsidian from the Mule Creek source area, and the material composed a large proportion of the flaked stone assemblage (Appendix A, this volume). Therefore, consumption patterns and reduction technology were a central focus of the analysis, with the goal of understanding how unrestricted access to obsidian influences technological behaviors at a late precontact site.

Research questions include:

(1) What core reduction methods were used? Was bipolar reduction—a common expedient method used to reduce small nodules—the primary mode of reduction, or were other techniques utilized?
(2) Was obsidian used only for projectile point production, or was it also used for tools needed for everyday domestic tasks? How does this compare with the use of other locally available raw material?
(3) Is there evidence for specialized projectile point production?

To address these questions, the flaked stone was divided into two gross raw material categories: obsidian and non-obsidian. Debitage attributes, core reduction methods, and tool distributions were examined to inform on the technological behaviors represented in each material category.

The second research goal involves identifying differences among Loci A, B, and C, where ceramic distributions revealed clear temporal and social differences (Chapter 3, this volume). This is accomplished by using debitage metrical data to construct technological profiles, which, in turn, can be used to compare reductive intensity and patterns of tool manufacture (Sliva 2005).

Research questions include:

(1) How do reductive techniques and tool manufacture patterns differ among loci?
(2) What temporal and cultural affiliation inferences can be made based on the projectile point styles represented at each locus?

ANALYSIS METHODS

The analyzed flaked stone sample was chosen from control units in Loci A, B, and C, and an equal proportion of obsidian and non-obsidian material was analyzed. For the assemblage recovered during the 2008 excavations, artifacts from each raw material group were roughly sorted by hand into four size groupings, and 50 percent of each size group was analyzed. The sample from the 2009 excavations was similarly sorted, and one-third of each size group was analyzed. All projectile points and retouched implements were analyzed regardless of context. This strategy resulted in the analysis of 1,322 flaked stone artifacts.

Artifact Classification

Artifact classification is based on a system developed for Desert Archaeology, Inc. (Sliva 1997, 2002, 2005, 2017). The classification scheme uses a division of gross artifact classes based on the presence or absence of retouch or blank type. This includes cores, debitage, unifaces, bifaces, core tools, and core hammers. Artifact type is then determined based on morphology, retouch patterns, and use-wear. Artifacts are coded individually, and recorded attributes include raw material, maximum linear dimension (mm), mass (g), presence/absence of cortex, and platform attributes when applicable. Additional measurements taken on projectile points include length, width, and thicknesses of the blade and base, neck width, and basal concavity.

Debitage

Debitage includes complete flakes, fragmentary flakes, and shatter. Bifacial thinning flakes are a special debitage type defined by a low platform angle, platform lipping, platform preparation, expanding flake margins, and a thin, curved cross section. Debitage is coded individually, and maximum linear dimension (mm) and weight (g) are recorded for each piece. Platform attributes are recorded as cortical, plain, faceted, or crushed. To express relative flake thickness, mass index is calculated as mass (g) divided by maximum dimension (mm), with higher values indicating thicker, blockier flakes (Sliva 2005, 2017).

Potential Retouch Flakes

Based on experimental data, Sliva (2017) introduced a method to identify the by-product of both unifacial and bifacial retouch by calculating the rate of potential retouch flakes. Potential retouch flakes are calculated as the set of debitage falling within the metrical parameters exhibited by bifacial thinning flakes. Potential retouch flakes include all identified bifacial thinning flakes, as well as all complete flakes with a mass index less than the mean mass index + 1-sigma for identified complete bifacial thinning flakes within the analyzed assemblage. Debitage that does not fall within these metrical parameters is considered core reduction debitage. Higher rates of potential retouch flakes indicate a higher rate of tool production and maintenance. Due to the difference in the size of the raw materials available, different mass index limits were used for obsidian (0.026) and non-obsidian (0.051) to calculate potential retouch flake rates.

Utilized Flakes

Utilized flakes are unretouched pieces of debitage that exhibit use-wear or modification from use. Utilized edges are identified based on macroscopically visible wear traces. Presumably purposefully selected from the debitage based on their shape, size, and raw material qualities, utilized flakes are considered implements and are discussed as such here.

Retouched Implements

Retouched implements are flakes or cores with modification through percussion flaking or pressure flaking, or a combination of both. Retouch is categorized according to the nature and extent of the retouch and edge angle (Table 4.1; after Rozen 1984:457–459). When retouch corresponds to a technological type, such as a scraper, chopper, or denticulate (toothed edge), these terms are used; however, it is important to note that form should not be equated with function.

Table 4.1. Definitions of retouch attributes and other design elements (from Sliva and Ryan 2012).

Retouch Type	Definition
Unifacial	Retouch scars that extend only one aspect, or face, of the implement
Bifacial	Retouch scars that extend from a common edge onto both aspects of the implement
Continuous	At least three contiguous retouch scars on a single edge
Discontinuous	Two or more noncontiguous retouch scars, but not more than two contiguous scars on a single edge
Invasive	Retouch scar extending from the edge a distance equal to or greater than 10 percent of the maximum distance to the opposite edge, measured along the flaking axis of the scar
Marginal	Retouch scar extending from the edge a distance less than 10 percent of the maximum distance to the opposite edge, measured along the flaking axis of the scar
Extensive	Continuous retouch scars whose combined extent is greater than 20 percent of the perimeter of the implement
Nonextensive	Continuous retouch scars whose combined extent is less than 20 percent of the perimeter of the implement
Acute edge	<30°
Medium edge	30–60°
Steep edge	>60°

Biface Reduction Stages

General bifaces that lack specialized components such as hafting elements or elongated drill bits are classified here as early-stage or late-stage bifaces, which is a useful way to recognize how extensively a piece has been worked. The biface stages used here are modified from Whitaker (1994; see also Andrefsky 2005:187–190) without the use of his specific stage numbers. Early-stage bifaces are the beginning of the shaping process, with trimmed edges and some flakes removed from the interior face and onto the ridge of the exterior face. Late-stage bifaces are thinner than early-stage bifaces, and they are shaped around the edges, have diffuse flake scars, little or no cortex, and are only lacking final thinning and hafting elements. Preforms are fully thinned and shaped bifaces that are missing only their hafting element. Nonextensively retouched biface is another classification used here, and it refers to flakes with discontinuous or marginal retouch limited to a small portion of the edge.

RAW MATERIAL

The 3-Up site is situated on the Gila Group composed of conglomerate, sandstone, and basalt, surrounded by rhyolite and basalt and andesite flow (http://tin.er.usgs.gov/geology). The site is located in the Mule Creek obsidian source area, and an abundance of obsidian is available around the site and in the bed of nearby Mule Creek. The obsidian nodules generally measure less than 10 cm, and four chemically distinct subgroups have been identified: Antelope Creek, Mule Creek-North Sawmill Creek, Mule Mountains, and the more recently identified Blue-San Francisco River nodules (Shackley 2005).

Obsidian composes a large proportion of the 3-Up flaked stone assemblage (n = 2,598), and 1,317 artifacts were chosen for energy dispersive x-ray fluorescence (XRF) source analysis at the University of Missouri Research Reactor Archaeometry Laboratory (see Tables A.3–A.4). The results show that 77 percent of the material is of the Antelope Creek group, with 21 percent from North Sawmill Creek and less than 1 percent from the Mule Mountains. Nonlocal obsidian consists of two pieces of obsidian from the Cow Canyon source, located approximately 30 km west of the 3-Up site.

A similar source distribution pattern was seen in the small sample of artifacts (*n* = 26) analyzed by Steven Shackley at the Geoarchaeological XRF Laboratory at University of California, Berkeley. Antelope Creek was the dominant source, with North Sawmill Creek, Mule Mountains, and Blue-San Francisco River subgroups also represented. Two pieces were from the Gwynn-Ewe Canyon source, located approximately 45 km northeast of the site in the Gila National Forest and possibly obtained during hunting expeditions or through exchange with groups closer to the source (Shackley 2010).

Forty-six percent of the analyzed assemblage is composed of obsidian (Table 4.2). The material has been noted to be brittle but responds well to pressure flaking (Shackley 2005:55). Thus, it is not surprising that the occupants of the 3-Up site preferred obsidian for their retouched tools. The sharp edges of unmodified obsidian flakes also make excellent cutting and slicing implements.

The rest of the assemblage consists of metamorphic, metavolcanic, igneous, and sedimentary rock, most of which was fine grained to very fine grained. Metamorphic and metavolcanic material occurs most frequently, and much of it is brittle, mafic rock that flakes well, although it would not be preferred for bifacial reduction. Fine-grained igneous material, including rhyolite and basalt, is also well represented, and a small quantity of fine- to very fine-grained quartzite was recovered. Cryptocrystalline material occurs at a rate of 15 percent, most of which was identified as chert or chalcedony.

Of the non-obsidian material, chert and chalcedony together were used most frequently for uniface production and were the only materials used other than obsidian for biface production. Chert colors include gray, brown, and white. A few pieces, including one core, appear to have been heat-treated to improve flaking quality. In a survey of the Mimbres River Valley and surrounding areas, no major chert sources were identified in the Upper Gila area (Fitting 1970), and the small quantity of chert at the 3-Up site may have been imported to the site or perhaps found in the streambed of Mule Creek.

Table 4.2. Raw material distributions, by locus, at the 3-Up site, LA 150373.

	Locus A		Locus B		Locus C		Site Total	
Raw Material	*n*	Percent	*n*	Percent	*n*	Percent	*n*	Percent
Obsidian, unspecified	130	28.9	43	7.9	109	33.5	282	21.3
Mule Creek-Antelope Creek obsidian	58	12.9	115	21.0	77	23.7	250	18.9
Mule Creek-N. Sawmill Creek obsidian	19	4.2	38	6.9	21	6.5	78	5.9
Mule Creek-Mule Mountain obsidian	0	0.0	2	0.4	0	0.0	2	0.2
Cow Canyon obsidian	0	0.0	1	0.2	0	0.0	1	0.1
Fine-grained rhyolite/basalt/ unspecified igneous	54	12.0	84	15.4	34	10.5	172	13.0
Medium-grained igneous	2	0.4	3	0.5	0	0.0	5	0.4
Fine-grained metavolcanic/metamorphic	66	14.7	92	16.8	38	11.7	196	14.8
Fine-grained metasediment	11	2.4	29	5.3	6	1.8	46	3.5
Fine- to very fine-grained quartzite	33	7.3	32	5.9	17	5.2	82	6.2
Medium-grained quartzite	0	0.0	1	0.2	0	0.0	1	0.1
Fine-grained sedimentary	2	0.4	3	0.5	1	0.3	6	0.5
Cryptocrystalline silicate	21	4.7	5	0.9	5	1.5	31	2.3
Chert	27	6.0	48	8.8	12	3.7	87	6.6
Chalcedony	21	4.7	47	8.6	4	1.2	72	5.4
Jasper	6	1.3	4	0.7	1	0.3	11	0.8
Total	450	99.9	547	100.0	325	99.9	1,322	100.0

LOCUS A

The 450 flaked stone artifacts from Locus A were all recovered from a trash concentration, Feature 10, Unit 301. Forty-six percent of the assemblage was composed of obsidian, and XRF results show that most is from the Antelope Creek locale, followed by North Sawmill Creek. The remainder of the assemblage is composed primarily of fine-grained metamorphic and igneous material, with chert and chalcedony also well represented.

Locus A has a relatively low debitage-to-core ratio, with debitage comprising 88 percent of the assemblage (Table 4.3). Obsidian cores outnumber non-obsidian cores, and bipolar cores are the dominant type (Table 4.4). The bipolar cores are generally small nodules with scarred platforms, as well as flake scars and crushing opposite the platform from contact with the anvil. Many of these are cortical nodules with flakes removed from half, and some had flakes removed around the entire perimeter of the core. In one instance, the lateral edge of the core was used as a platform after initial bipolar reduction. Non-obsidian cores are primarily single-platform and multiple-platform types, made of metavolcanic material, chert, and chalcedony.

The obsidian debitage is significantly smaller and lighter than the non-obsidian flakes due to the small size of the nodules and a greater degree of tool production. The rate of both bipolar flakes and bifacial thinning flakes is four times greater in the obsidian assemblage (Table 4.5), and 37 percent of complete flakes fall under the limit for potential retouch flakes, indicating a focus on obsidian tool production. The potential retouch flake rate in the non-obsidian debitage is also relatively high (21 percent); however, this was calculated with a much lower bifacial thinning flake sample, and it may not be as reliable an indicator of tool manufacture. More than 30 percent of the platform-bearing obsidian flakes in this assemblage are faceted, indicating platform preparation, and lipped platforms occurred at a rate of 17 percent (Table 4.6). In contrast, prepared platforms and lipped platforms in the non-obsidian group both occur at a rate of only 6 percent.

Two utilized flakes were identified among the debitage. Made of chert and chalcedony, these are similar in size, and both have microflaking and crescent-shaped breaks, suggesting they were used in a longitudinal motion, such as cutting or slicing.

Unifacially retouched flakes total eight, only two of which were made of obsidian (Table 4.7). One of the obsidian unifaces is a partial cortical flake with ventral retouch forming an irregular working edge and was possibly meant to be a scraper. The other has irregular invasive retouch on two edges but does not look like it would function well as a scraper.

The retouch patterns on the other six unifaces generally conform to traditional tool types and include scrapers, a possible wedge, and a microdenticulate. The microdenticulate is a chert flake with fine teeth on one lateral edge formed by pressure flaking. The possible wedge is a chunky flake made from white microcrystalline material with retouch and abrasion on the distal end, but without impact wear on the proximal end. The scrapers were produced on larger chert and metamorphic flakes.

A core scraper, a notch, and a utilized core are the only three core tools in the entire 3-Up site sample. A small obsidian bipolar core was retouched to form a slightly concave scraping edge. The other core tools are made of metamorphic material and are significantly larger. The utilized core has abrasive wear on one edge and may have been used as a scraper; the notch is a thick flake core with medium retouch forming a broad concavity along one edge.

Seven bifaces from Locus A include four in early and late stages of reduction, two nonextensively retouched flakes, and a drill. All the bifaces were pressure flaked, and all but one were made of obsidian. The drill was fashioned from a curved flake, with the platform serving as the drill base. The non-obsidian biface is a chalcedony flake with marginal pressure flaking along the distal end.

Although the contexts from Locus A were temporally mixed, the recovered projectile points are styles common to post-AD 1150 occupations throughout western New Mexico and southern and eastern Arizona. These include two Classic Side-notched points, four Arizona Triangular styles, and five nondiagnostic blade fragments (Figure 4.1; Table 4.8).

LOCUS B

The analyzed flaked stone assemblage from Locus B totals 547 pieces. These were recovered primarily from Unit 104 (*n* = 262) and Unit 105 (*n* = 283), which were excavated into trash concentrations; two projectile points from Unit 103 were also analyzed. This locus represents a possible thirteenth to fourteenth century Kayenta occupation.

The Locus B assemblage has the highest flake-to-core ratio and the lowest mean core size for both material groups, indicating greater reductive intensity. Obsidian comprises 36 percent of the analyzed assemblage, less than the other loci in this study. Most of the obsidian in this sample was from the Antelope Creek source, followed by North Sawmill Creek, two pieces from Mule Mountain, and a single piece from the Cow Canyon source. Metamorphic material, which includes metavolcanics, metasediments and quartzite, occurs at the same rate (28 percent) as the cryptocrystalline group, which includes chert, chalcedony, and jasper. Rhyolite, basalt, other fine- to medium-grained igneous material, and sedimentary rock make up the rest of the assemblage.

Debitage types include core reduction debris, bifacial thinning flakes, and bipolar flakes (see Table 4.5). Bipolar flakes were exclusive to the obsidian assemblage and comprise 4 percent of the debitage, similar to rates at the other loci. Bifacial thinning flakes make up almost 15 percent of the obsidian debitage, and the potential retouch flake rate is 32 percent. Although tool manufacture is well represented, there is a lower proportion of faceted platforms and a significantly higher percentage of crushed platforms when compared with the other loci (see Table 4.6).

A possible utilized flake and a pigment flake were among the debitage. A small obsidian flake with crescent-shaped breaks along the distal edge may have been used for slicing or cutting. However, given the brittle nature of obsidian, this could be the result of post-depositional damage. The pigment flake is a large quartzite flake with red pigment covering the ventral surface. This piece fits nicely in the palm of the hand, although no wear traces are evident, and its use is unknown.

Eight of the 12 cores were made of material other than obsidian, including igneous, metamorphic, chert, and chalcedony. Several core types were recovered, although many were fragmentary (see Table 4.4). Obsidian cores were few and included a multiple-platform, a split cobble, a small (20.3 mm) unmodified nodule, and a core fragment.

Unifaces were made from obsidian, chert, chalcedony, and quartzite (see Table 4.7). Those with specialized designed edges include a denticulate and an obsidian perforator; the remainder consists of scrapers, a unifacial tabular tool, and an obsidian flakes with marginal or irregular retouch. The obsidian scrapers are both thick cortical flakes with ventral retouch, and a slightly larger chert flake has retouch on the distal and lateral edges. The perforator is a long, narrow, bipolar flake with ventral retouch from the distal end extending approximately three-quarters the length of the flake. The tabular tool is a long thin piece of quartzite with continuous marginal retouch forming a somewhat sickle-shaped edge.

Table 4.3. Distribution of artifacts in the analyzed assemblage from three loci at the 3-Up site, LA 150373.

	Locus A						Locus B						Locus C						Site Total			
	Obsidian		Non-obsidian		Locus Total		Obsidian		Non-obsidian		Locus Total		Obsidian		Non-obsidian		Locus Total		Obsidian		Non-obsidian	
	No.	Percent	No.	Percent	No.	Percent	No.	Percent	No.	Percent	No.	Percent	No.	Percent	No.	Percent	No.	Percent	No.	Percent	No.	Percent
Debitage	171	82.6	224	92.2	395	87.8	159	79.9	335	96.3	494	90.3	188	90.8	113	95.8	301	92.6	518	84.5	672	94.8
Cores	16	7.7	10	4.1	26	5.8	4	2.0	8	2.3	12	2.2	11	5.3	2	1.7	13	4.0	31	5.1	20	2.8
Unifaces	2	1.0	6	2.5	8	1.8	4	2.0	2	0.6	6	1.1	2	1.0	2	1.7	4	1.2	8	1.3	10	1.4
Bifaces	6	2.9	1	0.4	7	1.6	20	10.1	2	0.6	22	4.0	3	1.4	0	0	3	0.9	29	4.7	3	0.4
Projectile points	11	5.3	0	0	11	2.4	12	6	0	0	12	2.2	3	1.4	1	0.8	4	1.2	26	4.2	1	0.1
Core tools	1	0.5	2	0.8	3	0.7	0	0	0	0	0	0	0	0	0	0	0	0	1	0.2	2	0.3
Other	0	0	0	0	0	0	0	0	1	0.3	1	0.2	0	0	0	0	0	0	0	0	1	0.1
Total	207	100.0	243	100.0	450	100.1	199	100.0	348	100.0	547	100.0	207	99.9	118	100.0	325	99.9	613	100.0	709	99.9

Table 4.4. Distribution of core types at the 3-Up site, LA 150373.

Core Type	Obsidian	Non-obsidian	Total	Percent
Locus A				
Single-platform	1	3	4	15
Multiple-platform	0	4	4	15
Bipolar	9	0	9	35
Bifacial	0	1	1	4
Flake core	0	1	1	4
Split cobble	2	0	2	8
Tested piece	1	0	1	4
Fragment	3	1	4	15
Total	16	10	26	100
Locus B				
Multiple-platform	1	3	4	33
Bipolar	0	0	0	0
Bifacial	0	1	1	8
Split cobble	1	0	1	8
Fragment	1	4	5	42
Unmodified nodule	1	0	1	8
Total	4	8	12	99
Locus C				
Multiple-platform	0	1	1	8
Bidirectional	1	0	1	8
Bipolar	3	0	3	23
Bifacial	0	1	1	8
Split cobble	3	0	3	23
Tested piece	2	0	2	15
Fragment	2	0	2	15
Total	11	2	13	100

Bifaces and projectile points comprise 16 percent of the obsidian assemblage, more frequent than any other locus. Bifaces total 18, and all reduction stages are represented. Sixty percent were recovered from Unit 104, a trash concentration associated with the primary room block.

Most of the bifaces are pressure-flaked obsidian flakes, except one chert drill and one chalcedony biface. One-third of the bifaces have remnants of cortex on the flake surface. Some of the bifaces were likely abandoned or were broken during manufacture; others may have been useful tools, such as a complete late-stage, tear-dropped-shaped biface with rounded glossy use-wear on the tip.

Diagnostic projectile points from Locus B are dominated by unnotched triangular styles. Unspecified types with low shallow notches and several nondiagnostic blade fragments were also recovered (Figure 4.2; see Table 4.8). The unnotched triangular points are analogous to Arizona triangular styles, which are widely distributed between AD 1150 and 1300.

LOCUS C

The flaked stone assemblage from Locus C consists of 325 artifacts associated with the late Salado occupation at the 3-Up site. The sample was collected from the fill of an adobe room block (n = 31) and from Unit 107 (n = 124) and Unit 108 (n = 170), which were control units excavated into sheet trash.

Table 4.5. Debitage types in the analyzed assemblage at the 3-Up site, LA 150373.

	Locus A		Locus B		Locus C		Site Total	
Material, Debitage Type	*n*	Percent	*n*	Percent	*n*	Percent	*n*	Percent
Obsidian								
Complete flake	94	55	75	47	81	43	250	48
Flake fragment	31	18	40	25	46	25	117	23
Split flake	1	<1	1	<1	4	2	6	1
Bipolar flake	7	4	7	4	7	4	21	4
Bifacial thinning flake	27	16	22	14	28	15	77	15
Bifacial thinning flake fragment	1	<1	1	<1	1	1	3	1
Utilized flake	0	0	1	<1	0	0	1	<1
Angular debris	10	6	12	8	21	11	43	8
Non-obsidian								
Complete flake	162	72	200	60	71	63	433	64
Flake fragment	34	15	87	26	25	22	146	22
Split flake	2	1	3	1	1	1	6	1
Bipolar flake	1	<1	0	0	0	0	1	<1
Bifacial thinning flake	9	4	9	3	5	4	23	3
Bifacial thinning flake fragment	0	0	1	<1	0	0	1	<1
Utilized flake	2	1	0	0	0	0	2	<1
Angular debris	14	6	34	10	11	10	59	9
Pigment flake	0	0	1	<1	0	0	1	<1

Table 4.6. Frequency of platform types represented in the analyzed assemblage at the 3-Up site, LA 150373.

Material	Locus	Total Platform-bearing Flakes	Cortical	Plain	Faceted	Cortical, Faceted	Crushed	Cortical, Crushed	Lip Present
Obsidian	A	135	41%	19%	28%	4%	7%	0%	17%
	B	118	44%	17%	19%	3%	14%	3%	9%
	C	127	45%	21%	23%	2%	6%	2%	14%
Non-obsidian	A	180	19%	73%	6%	1%	1%	0%	6%
	B	229	25%	69%	6%	0%	0%	0%	3%
	C	81	27%	67%	5%	0%	1%	0%	5%

The greatest frequency of obsidian was recovered from this locus, comprising 64 percent of the assemblage. XRF source results show that Antelope Creek material was used most frequently, followed by North Sawmill Creek. The distribution of the non-obsidian material differs somewhat from Loci A and B, with a higher frequency of metamorphic/metavolcanic and igneous material and less use of cryptocrystalline silicates.

This assemblage has the highest proportion of debitage and the lowest frequency of tools than either Loci A or B. Obsidian debitage consists of core reduction debris, bifacial thinning flakes, and a small quantity of bipolar flakes. A higher rate of prepared and lipped platforms occurs here, and 34 percent of the debitage falls within the parameters for potential retouch flakes. Compared with the other loci, the proportion of complete obsidian flakes is slightly lower while angular debris is higher, possibly indicating a greater emphasis on bipolar reduction of small obsidian nodules. Identified bipolar flakes comprise less than 4 percent of the debitage, but bipolar cores are the most frequently occurring type. The remaining obsidian cores consist

Table 4.7. Non-projectile tools at the 3-Up site, LA 150373.

Artifact Class	Locus	Unit	Feature No.	Context	Implement Type	Material	Maximum Length (mm)	FN/OSN
Utilized flake	A	301	10	Trash midden	Utilized flake/longitudinal wear	Chert	34.42	220
	A	301	10	Trash midden	Utilized flake/longitudinal wear	Chalcedony	36.27	220
Uniface	A	301	10	Trash midden	Acute invasive nonextensive retouch	Mule Creek-N. Sawmill Creek obsidian	22.94	273/2669
	A	301	10	Trash midden	Acute irregular uniface	Mule Creek-Antelope Creek obsidian	27.86	220/2372
	A	301	10	Trash midden	Medium side marginal extensive retouch fragment	Chert	25.02	216
	A	301	10	Trash midden	Microdenticulate	Chert	29.74	213
	A	301	10	Trash midden	Sidescraper	Chert	41.00	213
	A	301	10	Trash midden	Sidescraper	Fine-grained metamorphic	61.66	273
	A	301	10	Trash midden	Composite scraper	Chert	45.36	1233
	A	301	10	Trash midden	Wedge	Cryptocrystalline silicate	35.98	213
Biface	A	301	10	Trash midden	Early stage biface	Unspecified obsidian	29.16	1233
	A	301	10	Trash midden	Early stage biface	Unspecified obsidian	34.86	216
	A	301	10	Trash midden	Early stage biface	Unspecified obsidian	25.04	220
	A	301	10	Trash midden	Late stage biface	Mule Creek-N. Sawmill Creek obsidian	19.88	273/178
	A	301	10	Trash midden	Nonextensively retouched biface	Unspecified obsidian	20.47	213
	A	301	10	Trash midden	Nonextensively retouched biface fragment	Chalcedony	19.55	277
	A	301	10	Trash midden	Drill	Mule Creek-Antelope Creek obsidian	22.96	225
Core tool	A	301	10	Trash midden	Core notch	Fine-grained metamorphic	62.98	220
	A	301	10	Trash midden	Core scraper	Unspecified obsidian	21.60	213
	A	301	10	Trash midden	Utilized core	Very fine-grained quartzite	69.13	216
Utilized flake	B	104	4	Trash midden	Possible utilized flake/longitudinal wear	Mule Creek-N. Sawmill Creek obsidian	26.80	197/2200
	B	104	4	Trash midden	Pigment flake	Fine-grained quartzite	74.34	117
Uniface	B	104	4	Trash midden	Sidescraper	Mule Creek-Antelope Creek obsidian	31.95	197/2213
	B	104	4	Trash midden	Sidescraper	Mule Creek-Antelope Creek obsidian	31.64	154/2079
	B	104	4	Trash midden	Acute composite marginal extensive retouch	Mule Creek-Antelope Creek obsidian	27.74	147/2064
	B	105	5	Trash midden	Denticulated endscraper	Chalcedony	34.71	137
	B	105	5	Trash midden	Composite scraper	Chert	34.27	132
	B	105	5	Trash midden	Triangular perforator	Mule Creek-Antelope Creek obsidian	26.90	141/157
	B	105	5	Trash midden	Unifacial tabular tool	Fine-grained quartzite	95.40	137
Biface	B	104	4	Trash midden	Early stage biface	Mule Creek-N. Sawmill Creek obsidian	12.88	123/1960
	B	104	4	Trash midden	Early stage biface	Mule Creek-Antelope Creek obsidian	20.95	105/1887

Table 4.7. Continued.

Artifact Class	Locus	Unit	Feature No.	Context	Implement Type	Material	Maximum Length (mm)	FN/OSN
	B	104	4	Trash midden	Early stage biface	Mule Creek-Antelope Creek obsidian	38.08	105/1882
	B	104	4	Trash midden	Early stage biface	Mule Creek-Antelope Creek obsidian	17.59	95/1842
	B	104	4	Trash midden	Early stage biface	Mule Creek-Antelope Creek obsidian	12.95	117/1939
	B	104	4	Trash midden	Late stage biface	Chalcedony	34.21	154
	B	104	4	Trash midden	Late stage biface	Cow Canyon obsidian	27.21	95/1843
	B	104	4	Trash midden	Late stage biface fragment	Mule Creek-Antelope Creek obsidian	19.42	123/168
	B	104	4	Trash midden	Late stage biface fragment	Mule Creek-Antelope Creek obsidian	18.20	117/1943
	B	104	4	Trash midden	Nonextensively retouched biface	Mule Creek-Antelope Creek obsidian	24.85	197/2206
	B	104	4	Trash midden	Small biface fragment	Mule Creek-Antelope Creek obsidian	9.46	197/2205
	B	104	4	Trash midden	Preform	Mule Creek-Antelope Creek obsidian	26.16	197/163
	B	104	4	Trash midden	Preform	Mule Creek-Antelope Creek obsidian	25.74	97/153
	B	104	4	Trash midden	Preform fragment	Mule Creek-Antelope Creek obsidian	14.21	95/1854
	B	104	4	Trash midden	Drill fragment	Chert	29.69	105
	B	105	5	Trash midden	Early stage biface fragment	Unspecified obsidian	15.36	132
	B	105	5	Trash midden	Early stage biface fragment	Mule Creek-Antelope Creek obsidian	33.18	112/1910
	B	105	5	Trash midden	Late stage biface	Mule Creek-N. Sawmill Creek obsidian	19.63	112/1927
	B	105	5	Trash midden	Late stage biface	Mule Creek-Antelope Creek obsidian	33.17	141/155
	B	105	5	Trash midden	Late stage biface fragment	Mule Creek-Antelope Creek obsidian	15.38	167/2175
	B	105	5	Trash midden	Nonextensively retouched biface fragment	Unspecified obsidian	24.12	167
	B	105	5	Trash midden	Nonextensively retouched biface	Unspecified obsidian	24.65	137
Uniface	C	107	0	Sheet trash	Medium marginal extensive retouch	Fine-grained metamorphic	85.96	220
	C	107	0	Sheet trash	Acute composite marginal extensive retouch	Mule Creek-N. Sawmill Creek obsidian	27.44	220/2343
	C	108	0	Sheet trash	Acute retouched fragment	Unspecified obsidian	23.42	228
	C	108	0	Sheet trash	Acute denticulated marginal retouch	Chalcedony	19.41	228
Biface	C	107	0	Sheet trash	Early stage biface fragment	Mule Creek-Antelope Creek obsidian	25.53	220/2345
	C	108	0	Sheet trash	Early stage biface fragment	Mule Creek-Antelope Creek obsidian	16.30	233/2474
	C	108	0	Sheet trash	Late stage biface fragment	Unspecified obsidian	15.56	228

of split cobbles, tested pieces, and fragments. Only two of the cores are not obsidian, a large bifacial core made of metavolcanic material and a multiple-platform basalt core.

The four unifaces were manufactured from obsidian, chalcedony, and metamorphic material; these have either marginal retouch or pressure-flaked edges, and one small chalcedony flake has marginal retouch forming two denticulated edges. Bifaces consist of three fragmentary pressure-flaked obsidian bifaces and four projectile points. Only one complete point, a Pueblo Side-notched style, could be identified (Figure 4.3a); the others are fragmentary blade fragments.

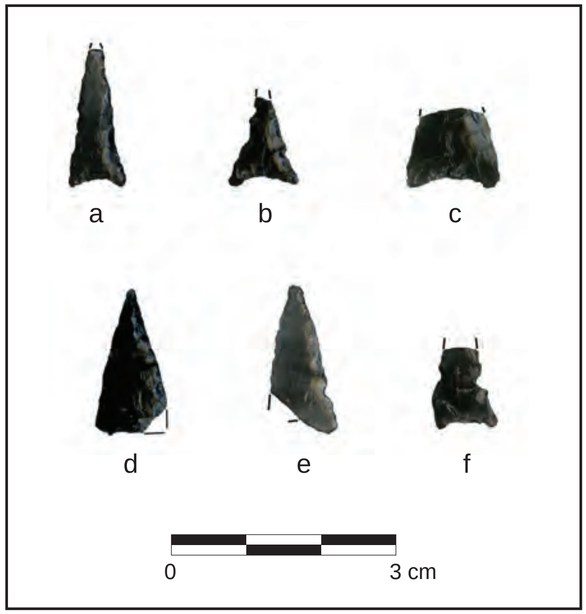

Figure 4.1. Select projectile points recovered from Locus A at the 3-Up site, LA 150373: (a–d) Triangular unnotched styles; (e–f) Classic Side-notched styles.

PROJECTILE POINTS

The 27 projectile points from the 3-Up site represent pan-regional styles commonly associated with post-AD 1150 occupations (see Table 4.8). Type names used in this analysis follows Sliva's (2002, 2006) typology for styles that occur in central and southern Arizona, as well as in western New Mexico.

The two Classic Side-notched points identified were exclusive to Locus A. These are triangular points with shallow contracting side notches near the midpoint of the blade and straight to concave bases. This style is widely distributed in southeastern Arizona and western New Mexico between AD 1150 and 1350 (Sliva 2006:Figure 2.7f, Table 2.5). Points of this style were most often associated with the late Pueblo period in the Mogollon Highlands (Moore 1999:66, Figure3.12 o–s) and in late deposits at Bat Cave (Dick 1965:Figure 20.c). Two unspecified side-notched points were recovered from Locus B. These have shallow side notches located relatively low on the blade and rounded ears. These appear expediently manufactured, and the original flake surface is still visible on one of the examples.

The most common projectile point types at the 3-Up site are triangular unnotched styles; these were recovered from Locus A and Locus B. It is difficult to differentiate unnotched points from preforms, although given the small size, these likely represent finished points. Unnotched triangular points are analogous to Arizona Triangular point types that have been documented spanning multiple regions and cultural affiliations, including Hohokam, Salado, Mogollon, Sinagua, Anasazi, and Cohonina; these are most often associated with occupations dating AD 1150–1350 (Sliva 2006:56–59, Table 2.5), an interval equivalent to the Black Mountain and early Cliff phases in the Upper Gila region.

Varieties of this style include the Arizona Short Triangular type that measures less than 20 mm and that has a low length to width ratio, the longer and narrower Arizona Triangular points that tend to have straight or only slightly concave bases, and the Arizona Concave-base triangular type that has a markedly concave base (Sliva 2006:56). Because this style is also common in the Mimbres region, they are referred to here as Southwest Triangular points. Unnotched triangular points were associated with the Cliff phase in the Mimbres Valley (Nelson and LeBlanc 1986) and with the Salado or Cliff phase occupation at the nearby Ormand Village (Wallace 1998:Figure 125 a, d). Several variations were associated with late Pueblo period contexts in the Mogollon Highlands (Moore 1999). This point form has been described as the "characteristic arrow-

Table 4.8. Projectile points from the 3-Up site, LA 150373.

Locus, Unit No.	Point Type	Feature No.	FN/OSN	Condition	Material	Weight (g)	Total Length (mm)	Blade Length (mm)	Blade Width (mm)	Black Thickness (mm)	Neck Width (mm)	Basal Width (mm)	Figure No.
Locus A													
301	Classic Side-notched	10	225/181	Promixal fragment	Mule Creek-Antelope Creek obsidian	0.20	11.01	–	5.72	2.10	5.23	8.27	4.1f
301	Classic Side-notched	10	225/183	One ear missing	Mule Creek-Antelope Creek obsidian	0.25	19.53	13.73	7.37	1.66	–	–	4.1e
301	Nondiagnostic blade	10	213/174	Distal fragment	Mule Creek-Antelope Creek obsidian	0.21	13.78	–	–	2.52	–	–	–
301	Nondiagnostic blade	10	213/176	Distal fragment	Mule Creek-Antelope Creek obsidian	0.36	12.98	–	10.36	2.42	–	–	–
301	Nondiagnostic blade	10	213/177	Medial fragment	Mule Creek-Antelope Creek obsidian	0.31	10.94	–	9.32	2.42	–	–	–
301	Nondiagnostic blade	10	225/180	Distal fragment	Mule Creek-Antelope Creek obsidian	0.40	22.42	–	2.52	–	–	–	–
301	Nondiagnostic blade	10	277/173	Distal fragment	Mule Creek-Antelope Creek obsidian	0.27	17.37	–	–	1.90	–	–	–
301	Southwest Triangular	10	282/185	One ear missing	Mule Creek-Antelope Creek obsidian	0.38	19.64	19.64	9.20	2.47	–	–	4.1d
301	Concave base fragment	10	213/175	Base only	Mule Creek-N. Sawmill Creek obsidian	0.29	10.28	–	–	2.22	–	12.53	4.1c
301	Southwest Short Triangular	10	225/182	Complete	Mule Creek-Antelope Creek obsidian	0.14	11.68	11.68	7.23	1.82	–	9.32	4.1b
301	Southwest Triangular	10	282/186	Complete	Mule Creek-Antelope Creek obsidian	0.32	18.26	–	6.22	2.68	–	–	4.1a
Locus B													
103	Shallow side-notched	0	261/158	Complete	Mule Creek-N. Sawmill Creek obsidian	0.21	16.19	11.08	7.06	1.83	6.83	9.99	4.2i
103	Southwest Short Triangular	9	276/161	Complete	Mule Creek-Antelope Creek obsidian	0.16	13.05	13.05	6.61	2.21	–	7.79	4.2c
104	Southwest Short Triangular	4	97/154	Ear missing	Mule Creek-Antelope Creek obsidian	0.19	13.95	13.95	6.14	1.90	–	–	4.2d
104	Shallow side-notched	4	105/166	Complete	Mule Creek-N. Sawmill Creek obsidian	0.30	19.59	13.17	7.18	1.58	5.38	8.39	4.2h
104	Southwest Triangular	4	123/169	Proximal fragment	Mule Creek-Antelope Creek obsidian	0.20	11.89	–	7.09	2.44	–	7.75	4.2f
104	Southwest Triangular	4	197/165	Proximal fragment	Mule Creek-N. Sawmill Creek obsidian	0.28	11.13	–	–	–	–	10.72	–
104	Southwest Short Triangular	4	197/164	Complete	Mule Creek-Antelope Creek obsidian	0.22	12.33	12.33	–	2.18	–	8.89	4.2e
105	Unspecified type	5	132/172	Proximal fragment	Mule Creek-N. Sawmill Creek obsidian	0.24	13.24	–	5.90	2.11	–	7.34	4.2g
105	Nondiagnostic blade	5	132/170	Distal fragment	Mule Creek-Antelope Creek obsidian	0.23	17.07	–	8.12	1.73	–	–	–
105	Nondiagnostic blade	5	132/171	Medial fragment	Mule Creek-Antelope Creek obsidian	0.27	16.35	–	–	2.49	–	–	–
105	Southwest Triangular	5	137/167	Very tip missing	Mule Creek-Antelope Creek obsidian	0.47	22.07	–	8.73	2.32	–	6.50	4.2a
105	Southwest Short Triangular	5	141/156	Complete	Mule Creek-Antelope Creek obsidian	0.13	14.70	14.70	–	1.68	–	6.50	4.2b
Locus C													
106	Nondiagnostic reworked blade	7	162/160	Distal fragment	Mule Creek-Antelope Creek obsidian	0.89	19.86	–	11.43	3.70	9.96	–	–
107	Nondiagnostic blade	0	204/–	Distal fragment	Fine-grained igneous	1.32	20.04	–	–	–	–	12.88	–
107	Unspecified side-notched	0	204/159	Complete	Mule Creek-Antelope Creek obsidian	0.58	23.80	16.09	9.30	2.50	6.01	–	4.3a
108	Nondiagnostic blade	0	228/162	Distal fragment	Mule Creek-Antelope Creek obsidian	0.21	13.47	–	–	2.07	–	–	4.3b

point of the Tsegi phase" (AD 1250–1300) for the Kayenta culture in northeastern Arizona (Lindsay 1969:277, Figure 38a–e). The small obsidian nodules available in this region were adequate for the manufacture of these small unnotched points.

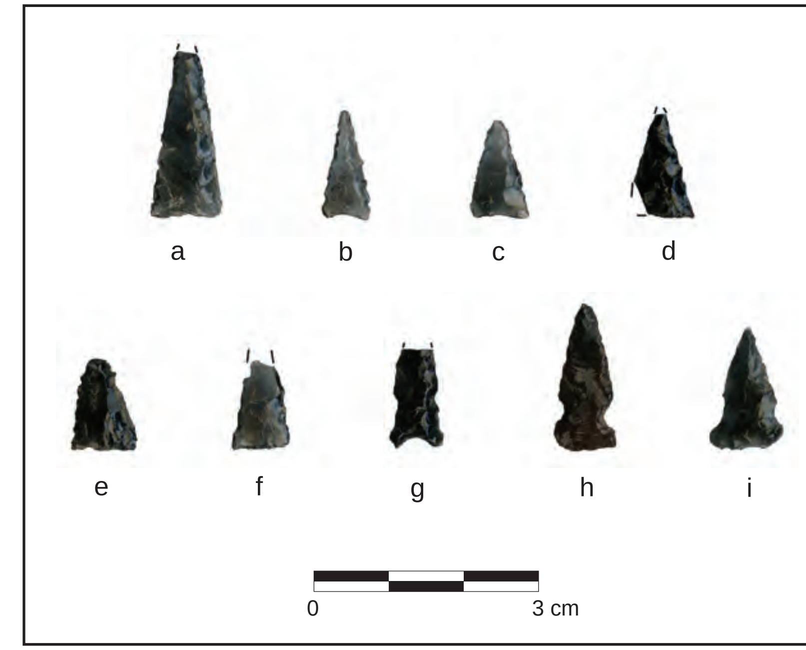

Figure 4.2. Select projectile points recovered from Locus B at the 3-Up site, LA 150373: (a–g) Triangular unnotched styles; (h–i) Shallow Side-notched styles.

A Pueblo Side-notched point was the only point from Locus C complete enough to be assigned to a type. This obsidian point has wide contracting notches that are deeper and placed lower on the blade than the Classic Side-notched type. The example from Locus C was skillfully made and the blade had been reworked, resulting in one incurvate blade margin (Figure 4.3).

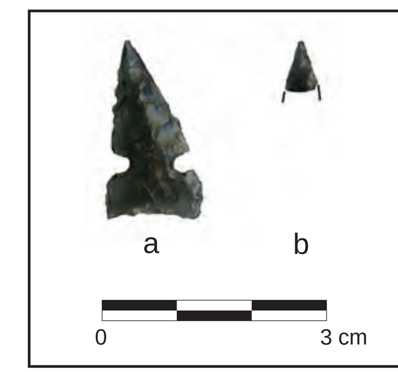

Figure 4.3. Projectile points recovered from Locus C at the 3-Up site, LA 150373: (a) Pueblo Side-notched point; (b) nondiagnostic blade fragment.

This point type has a wide distribution in central and eastern Arizona and western New Mexico, and it is temporally associated with the Pueblo III/Pueblo IV era, circa AD 1150–1450 (Sliva 2006:Table 2.5). A similar type made of Mule Creek obsidian was found on the floor of a Salado phase room at Ormand Village (Wallace 1998:Figure 125g), and other examples from Cliff phase deposits were recovered from sites in the Mimbres Valley (Nelson and LeBlanc 1986:Figure 8.1:B, G, SS, TT).

This style also resembles Late Classic Side-notched points associated with post-AD 1300 Hohokam occupations in southern Arizona (Sliva 2002; Ryan 2016:Table 6.7), and four made of Mule Creek/Antelope Creek-Mule Mountain obsidian were found at late Classic sites in the San Pedro Valley (Shackley and Gallop 2012; Sliva 2013). Similar points are also documented from the Mogollon Highlands (Moore 1999:Figure 3.12 a, d, e, g), although they are grouped together with a variety of small side-notched points that date from the Late Pit House to the Pueblo period. The presence of this point type in Locus C supports a late Salado occupation of that area.

TECHNOLOGICAL BEHAVIORS

To interpret the flaked stone technology at the 3-Up site and how it compares among the three loci, core reduction strategies and tool production patterns were examined for each raw material group.

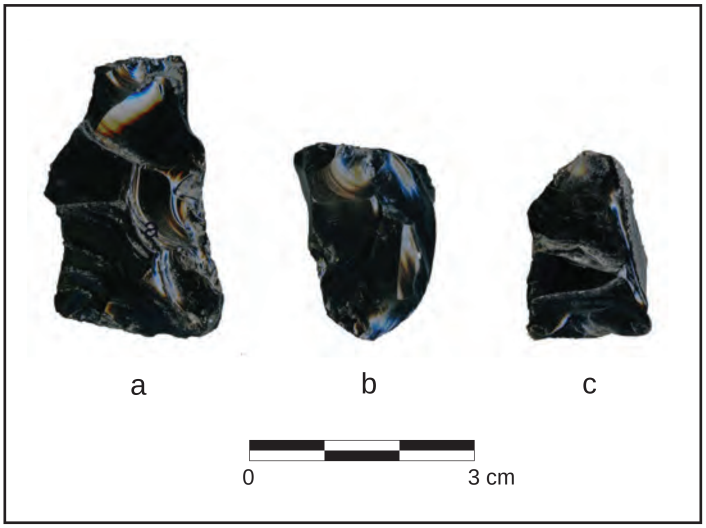

Figure 4.4. Examples of bipolar cores recovered from the 3-Up site, LA 150373: (a) Locus A, Unit 301, FN 220; (b) Locus C, Unit 107, FN 204; (c) Locus A, Unit 301, FN 273.

Reduction Patterns

Bipolar cores occur most frequently in the obsidian assemblage, followed by split cobbles and fragmentary cores. Bipolar percussion is commonly used as an expedient way to reduce small raw material nodules, particularly of chert and obsidian (Huckell 1981:199; Lekson 1990:62; Odell 2003:59–61). This method involves placing the nodule on a hard surface and using a hammerstone to strike directly from above, parallel to the vertical axis, effectively splitting the nodule or creating usable flakes. The resultant assemblage is sometimes difficult to identify and is characterized by a significant amount of shatter and blocky flakes with crushed platforms, pronounced ripple marks, and diffuse bulbs of force. Bipolar cores are often amorphously shaped with force apparent on opposite ends from both the percussor and the anvil (Figure 4.4) (Ahler 1989; Andrefsky 2005; Crabtree 1972; Magne 1989; Odell 2003).

Based on core types, the greatest evidence for bipolar reduction is seen in Locus A and Locus C. Bipolar cores were absent in Locus B, which had fewer obsidian cores in general. Bipolar flakes occurred in equally low proportions at all loci (4 percent), although it has been noted that the flakes produced during bipolar reduction can be difficult to discern from those produced using other hard-hammer percussion techniques (Barham 1987). Given the quantity of bipolar cores, the low frequency of angular debris and the high proportion of complete flakes in the 3-Up site assemblage were surprising.

Using their own experimental data and citing the results of others, Kujit et al. (1995) noted that bipolar reduction produces large amounts of shatter and angular debris, and only a small proportion of complete flakes. However, Amick and Mauldin (1997) argue that this could be a result of both technique and hammerstone material, because their reduction experiment resulted in a very low rate of non-orientable fragments. The material of the hammerstones used at 3-Up is not currently known, but a difference in the brittleness of obsidian from various sources could also be a factor in the quantity of shatter produced. The variability in flaking quality of the Mule Creek material was observed in an experiment conducted by Loome (2013). Some nodules were so brittle that they produced a high amount of unusable debris, while the more translucent material seemed to exhibit superior flaking quality and predictability (Loome 2013).

Split obsidian nodules were found in every locus and were differentiated from bipolar cores based on their lack of crushing or other evidence of anvil-related damage opposite the platform. These may have been reduced using a technique described by Whittaker (1994:115) that involves placing the nodule on a flexible surface as opposed to a hard anvil and striking with great force at right angles to the surface splitting the nodule so that the flat interior can be used as a platform. This technique is similar to the method preferred by experienced flintknapper Allen Denoyer (personal communication 2013). By selecting nodules with small facets, using only the leg for support, and striking with a small hammerstone, platforms can be created, and usable flakes can be produced with a minimal amount of shatter.

Reductive behavior can also be interpreted using debitage attributes. The obsidian debitage from each locus shows striking similarities in terms of size, mass index, cortical coverage, and the frequency of tool manufacture debris; mean core size is also consistent (Table 4.9). The large number of complete flakes with some cortex is not surprising given the small size of the available obsidian nodules. Obsidian flakes with partial cortex were sometimes chosen for bifacial reduction and would have also been suitable for unmodified cutting tools. Although most of the obsidian flakes are the result of core reduction, tool manufacture debitage is also well represented, with potential retouch flakes ranging from 32 to 37 percent. Soft-hammer percussion, using an antler billet or possibly a soft stone, and pressure flaking is also evident with faceted, lipped platforms and small bifacial thinning flakes, most prevalent in Locus A.

In sum, obsidian nodules were often reduced using expedient hard-hammer percussion techniques, but soft-hammer percussion and pressure flaking were frequently used to manufacture obsidian tools. Bipolar percussion was a common method, although the variety of core types indicates knappers at the 3-Up site were able to remove flakes using other percussion techniques.

A wider variety of core types is seen in the non-obsidian assemblage. Raw material consists primarily of fine-grained igneous and metamorphic rock, as well as cryptocrystalline material. In raw form, this material was larger than the available obsidian, meaning reduction strategies were not as limited. Many of the cores have multiple platforms and were struck in an opportunistic fashion; however, some standardized reduction is evident by the presence of bifacial cores and the low frequency of prepared platforms at each locus. Cortex coverage approaches or exceeds 50 percent at every locus, and some cortex was observed on 65 percent of the cores. These materials were likely collected in the vicinity of the site, and there is no indication primary core reduction occurred elsewhere. The non-obsidian material was useful for larger tools that were needed for domestic tasks and also used without modification.

Tool Distributions and Specialized Production

Considering all material types, the greatest variety of retouched tools was found in Locus A. Formal and expedient tools were manufactured from obsidian, but other materials were also used for unifaces and core tools (Table 4.10). Compared with other loci, a wider range of tasks is represented here, likely the result of the long span of occupation and the temporally mixed deposits in this area.

The highest percentage of obsidian bifaces and projectile points is seen in Locus B. These include complete and fragmentary bifaces in various stages of reduction, as well as the only preforms recovered from the 3-Up site. The bifaces may represent a combination of general purpose tools and pieces discarded during projectile point production, either due to manufacture-related breaks or difficulties encountered that would prevent further thinning. The quantity of tool manufacture debris and the frequency of bifaces and projectile points indicate that obsidian tool production was an important part of the technology at Locus B.

Intensive use of obsidian is apparent in Locus C, but far fewer tools were recovered. Except the projectile points, the tools recovered are marginally retouched unifaces and general bifaces. The assemblage from this late Salado occupation indicates a less diverse range of activities, as well as a focus on obsidian reduction and formal tool production. This suggests that technological behaviors at the 3-Up site changed through time; however, this inference is made with caution because much of the assemblage was recovered from shallow sheet-trash contexts.

Based on archaeological and ethnographic research, Andrefsky (1994, 2005:155–159) has shown that an abundance of high quality raw material results in an equal proportion of formal and informal tools regardless of settlement type. Although the tools in this study were not grouped using his informal/formal rubric, the

Table 4.9. Technological profiles, by material type, for each locus at the 3-Up site, LA 150373.

		Complete Flakes				Bifacial Thinning Flakes			Cores		Cortex Coverage Percentage[b]		
	Total Analyzed Debitage	Quantity	Average Maximum Length (mm)	Mass Index[a]	Potential Retouch Flake Percentage	Quantity	Average Maximum Length (mm)	Mass Index[a]	Quantity	Average Size (mm)	Complete	Partial	None
Locus A													
Obsidian	171	128	20.03	0.059	37	27	15.3	0.022	16	29.5	11.7	54.7	33.6
Non-obsidian	224	174	31.04	0.152	21	9	18.6	0.034	10	62.7	8.6	35.6	55.7
Locus B													
Obsidian	159	105	20.48	0.065	32	22	14.7	0.019	4	27.1	14.3	53.3	32.4
Non-obsidian	335	210	31.94	0.150	18	9	20.4	0.029	8	48.9	6.7	41.9	51.4
Locus C													
Obsidian	188	116	19.99	0.068	34	28	13.7	0.018	11	28.9	16.4	50.9	32.8
Non-obsidian	113	76	30.70	0.156	19	5	18.3	0.029	2	71.4	1.3	53.9	44.7

[a]Mass index is weight in grams/maximum linear dimensions.

[b]Complete flakes only.

Table 4.10. Distribution of implements, by material type, at the 3-Up site, LA 150373.

	Locus A		Locus B		Locus C	
Material	Obsidian	Other	Obsidian	Other	Obsidian	Other
Unifaces	2	6	4	2	2	2
Bifaces	8	1	23	2	4	0
Preforms/projectile points	11	0	15	0	3	1
Core tools	1	2	0	0	0	0
Utilized flakes	0	2	1	0	0	0

analysis does show that obsidian was used for both formally designed tools and, to a lesser extent, expediently retouched implements. It is also probable that more obsidian flakes were utilized than were identified here through macroscopic analysis. Of the non-obsidian material, cryptocrystalline and metamorphic rock was preferred for scrapers and denticulates, and chert and chalcedony were occasionally chosen for biface reduction. The size of the material in raw form would have also influenced behaviors, with materials other than obsidian needed for tasks that called for larger, heavier implements.

Occupants of the 3-Up site may have played a key role in the expanded circulation of Mule Creek obsidian nodules after AD 1300, a phenomenon that is linked to the arrival of Kayenta migrant groups in the region (Clark 2010; Clark et al. 2008; Clark et al. 2011; Clark, Hill, Lyons et al. 2012:390-393; Jones 2012; Jones and Shackley 2010; Peeples 2013:15). Given the abundance of obsidian debitage, the assemblage was examined for evidence of large-scale projectile point production for distribution or exchange. There is clear evidence for formal tool production at the site, and the projectile point types are styles that are widely distributed throughout southeastern Arizona and western New Mexico, although bifacial thinning flakes do not comprise a large proportion of the assemblage, and the calculated potential retouch flake rates are also not particularly high.

One challenge in identifying specialized production is the potential for a low recovery rate of small pressure flakes produced during the manufacture of the obsidian arrow points. These small thin flakes would fall through a ¼-inch mesh screen, and they could have also been transported away from the area during rainfall and redeposited elsewhere (Schiffer 1987:203).

Whittaker and Kaldahl (2001) examined debitage mass to determine if bifaces produced in an area of Grasshopper Pueblo, AZ P:14:1 (ASM), may have left the site. At the 3-Up site, bifacial thinning flakes comprise less than 5 percent of obsidian mass at each locus, and 8 percent or less when flakes that fall within potential retouch flake parameters are included (Table 4.11). Varying debitage and tool mass proportions among the three loci potentially signify difference in production levels; however, the overall low percentage does not indicate specialized point production. Controlled knapping experiments using bipolar and other reduction techniques would be beneficial to accurately identify the signatures of large-scale point production using small obsidian cores. Specifically, it would be useful to learn the success rate of producing usable flakes from the nodules, the metrics of the debris produced, and the amount of core mass lost during reduction.

SUMMARY AND CONCLUSIONS

Obsidian core reduction and tool production were a major focus at all three loci at the 3-Up site, but variations in the intensity of obsidian use are evident. A slightly greater reliance on non-obsidian material for larger general-purpose tools and a wider variety of subsistence or manufacturing implements is evident in Locus A, likely due to the greater time depth represented at this locus. The lowest frequency of obsidian use is seen in Locus B, where an emphasis on biface production is apparent. Obsidian use increases through time,

Table 4.11. Obsidian mass (in grams), by locus, at the 3-Up site, LA 150373.

	Analyzed Obsidian		Tools		Analyzed Debitage		Bifacial Thinning Flakes		Potential Retouch Flakes	
	Mass	Percent of Total Recovered	Mass	Percent of Total Recovered	Mass	Percent of Total Recovered	Mass	Percent of Total Recovered	Mass	Percent of Total Recovered
Locus A	348.84	52.3	21.04	3.2	205.47	58.9	9.48	4.6	16.71	8.1
Locus B	264.00	63.4	38.50	9.2	201.48	76.3	6.50	3.2	10.14	5.0
Locus C	369.53	61.9	10.80	1.8	272.15	73.6	7.06	2.6	10.96	4.0

dominating the assemblage associated with the late Salado occupation at Locus C, although far fewer tools were associated with this occupation.

In all areas, obsidian was most often used for bifacially retouched tools but was also used to a lesser extent for scrapers and expediently retouched implements. The larger obsidian flakes were chosen for bifacial reduction, and the obsidian arrow points were manufactured using pressure flaking. Projectile point production occurred at the site, although there is not strong evidence to argue for specialized point production for exchange.

Bipolar reduction was the preferred method for working the relatively small obsidian nodules. This method could produce flakes for retouch as well as sharp-edged flakes that could be used without modification. The latter may have been one of the goals of using this method, particularly at Locus A where evidence for bipolar reduction is greatest. Non-obsidian material available in the vicinity also had good flaking qualities and was slightly preferred over obsidian for uniface production and core tools. This material would have been preferred for tasks that required larger, heavier tools.

All the recovered points are styles common after AD 1150, and some stylistic preferences are evident among the loci. Classic Side-notched points were only present in Locus A, and unnotched triangular points were favored in Locus B, possibly a reflection of the cultural differences between these two loci. The Pueblo Side-notched point at Locus C is congruous with the late Salado occupation in this area.

Acknowledgments

I would like to thank Allen Denoyer for sharing and demonstrating his knapping techniques using Mule Creek obsidian.

CHAPTER 5

FAUNAL REMAINS

Britt M. Starkovich and Lewis Borck
(compiled by Deborah Huntley)

METHODS

The faunal sample from the 3-Up site, LA 150373, is fairly small, totaling 958 analyzed specimens (Table 5.1). Remains were identified using the zooarchaeological reference collection in the Stanley J. Olsen laboratory at the Arizona State Museum (ASM). Dr. Barnet Pavao-Zuckerman and Benjamin Curry assisted with skeletal identifications. Skeletal specimens were identified to genus and species, family, or body size categories and to the anatomical part of the skeleton.

The authors here used slightly different terminology and methodology. Starkovich followed Grayson (1984) and Lyman (1994) for terminology for basic counting units and Stiner (1994, 2005) for coding elements, portions of elements, age criteria, and taphonomic variables. Starkovich also recorded additional data for each specimen, including fusion state for bones, wear stage for mandibular teeth, presence of burning damage and burning intensity stages (Stiner et al. 1995), and surface damage from tool marks, weathering, gnawing animals, and plant roots (Fisher 1995). Borck adopted the standard faunal analysis coding system used by Desert Archaeology, Inc. to code taxa, bone elements, side, amount of specimen present, bone portion, fusion, burning, and natural, human, and/or animal modifications. Borck also recorded weights for total specimens per individual taxa per excavation level for Unit 301. Both original reports are on file at Archaeology Southwest.

RESULTS

Several different mammalian, bird, and fish species were identified from the 3-Up site assemblage, although less than 20 percent of the remains could be identified to a specific family or species (see Table 5.1). The dominant identified taxa are *Sylvilagus* sp. (cottontail) and *Odocoileus virginianus* or *O. hemionus* (mule or white-tail deer). Approximately 7 percent of the unidentifiable remains were classified as "small mammal," and about 60 percent were designated as "medium ungulate," which likely represent cottontail rabbits and deer, respectively.

Other identifiable mammalian remains include small amounts of *Canis familiaris* or *C. latrans* (domestic dog or coyote), *Ovis canadensis* (bighorn sheep), possible *Cervus canadensis* (elk), *Antilocapra americana* (pronghorn), *Lepus californicus* (black-tailed jackrabbit), Sciuridae sp. (squirrel or prairie dog), *Dipodomys* sp. (kangaroo rat), and *Thomomys bottae* (pocket gopher). Some birds were also identified to family or species, including Picidae (woodpecker or flicker), *Callipepla squamata* (scaled quail), *Buteo jamaicensis* (red-tailed hawk), and *Meleagris gallopavo* (turkey). Fish recovered included Catostomidae (suckers).

Number of identifiable specimens (NISP) is the basic counting unit from which the minimum number of individuals (MNI) was calculated. MNI is derived from the highest count of the most commonly occurring portion of an element, divided by the number of times it occurs in the body. MNI is a standard zooarchaeological quantification method, although the measure has several well-known biases. For example, MNI highlights smaller-bodied over larger-bodied taxa. Some elements are more easily identified, which results in the

Table 5.1. Number of individual specimens of species, by locus, from the 3-Up site, LA 150373.

	Locus A		Locus B		Locus C		Locus F		Locus G		Total	
	n	%	*n*	%	*n*	%	*n*	%	*n*	%	*n*	%
Unknown fish	0	0.0	20	2.6	0	0.0	0	0.0	0	0.0	20	2.1
Catostomidae (suckers)	0	0.0	4	0.5	0	0.0	0	0.0	0	0.0	4	0.4
Small birds	0	0.0	2	0.3	0	0.0	0	0.0	0	0.0	2	0.2
Picidae (woodpecker or flicker)	0	0.0	1	0.1	0	0.0	0	0.0	0	0.0	1	0.1
Medium birds	0	0.0	3	0.4	0	0.0	0	0.0	0	0.0	3	0.3
Callipepla squamata (scaled quail)	0	0.0	0	0.0	0	0.0	1	12.5	0	0.0	1	0.1
Large birds	0	0.0	7	0.9	0	0.0	0	0.0	0	0.0	7	0.7
Buteo sp. (hawk)	1	0.6	0	0.0	0	0.0	0	0.0	0	0.0	1	0.1
Buteo jamaicensis (red-tailed hawk)	0	0.0	1	0.1	0	0.0	0	0.0	0	0.0	1	0.1
Meleagris gallopavo (turkey)	0	0.0	3	0.4	0	0.0	0	0.0	0	0.0	3	0.3
Indeterminate bird	2	1.1	0	0.0	0	0.0	0	0.0	0	0.0	2	0.2
Small mammal or bird	0	0.0	2	0.3	0	0.0	0	0.0	0	0.0	2	0.2
Small mammal	11	6.3	57	7.6	0	0.0	0	0.0	2	15.4	70	7.3
Medium mammal	0	0.0	1	0.1	0	0.0	0	0.0	0	0.0	1	0.1
Large mammal	69	39.7	0	0.0	0	0.0	0	0.0	0	0.0	69	7.2
Indeterminate mammal	44	25.3	0	0.0	0	0.0	0	0.0	0	0.0	44	4.6
Unknown rodent	2	1.1	6	0.8	0	0.0	0	0.0	0	0.0	8	0.8
Thomomys bottae (pocket gopher)	1	0.6	8	1.1	1	6.3	0	0.0	0	0.0	10	1.0
Sciuridae sp. (squirrel or prairie dog)	2	1.1	1	0.1	0	0.0	0	0.0	0	0.0	3	0.3
Dipodomys sp. (kangaroo rat)	1	0.6	0	0.0	0	0.0	0	0.0	0	0.0	1	0.1
Leporidae	2	1.1	0	0.0	0	0.0	0	0.0	0	0.0	2	0.2
Sylvilagus sp. (cottontail)	8	4.6	37	5.0	0	0.0	0	0.0	1	7.7	46	4.8
Lepus californicus (black-tailed jackrabbit)	7	4.0	3	0.4	0	0.0	0	0.0	0	0.0	10	1.0
Medium ungulate	3	1.7	531	71.1	13	81.3	4	50.0	6	46.2	557	58.1
Odocoileus virginianus or *O. hemionus* (white-tailed or mule deer)	10	5.7	55	7.4	1	6.3	3	37.5	4	30.8	73	7.6
Ovis canadensis (bighorn sheep)	1	0.6	1	0.1	0	0.0	0	0.0	0	0.0	2	0.2
cf. *Cervus canadensis* (elk or large deer)	2	1.1	0	0.0	0	0.0	0	0.0	0	0.0	2	0.2
Antilocapra americana (pronghorn)	1	0.6	0	0.0	0	0.0	0	0.0	0	0.0	1	0.1
Large ungulate	0	0.0	1	0.1	0	0.0	0	0.0	0	0.0	1	0.1
Canis familiaris or *C. latrans* (dog or coyote)	0	0.0	1	0.1	1	6.3	0	0.0	0	0.0	2	0.2
Canis familiaris (domestic dog)	0	0.0	2	0.3	0	0.0	0	0.0	0	0.0	2	0.2
Indeterminate vertebrate	7	4.0	0	0.0	0	0.0	0	0.0	0	0.0	7	0.7
Grand Total	174	100.0	747	100.0	16	100.0	8	100.0	13	100.0	958	100.0

inflation of dietary contributions. The assumption that an entire individual was utilized at a site is intrinsic to MNI calculations. However, ethnographic evidence indicates this was not always the case (Perkins and Daly 1968. Larger individuals, as well as species used for ritual purposes, are good examples (Thomas 1971; White 1953). MNI for the 3-Up faunal assemblage are summarized in Table 5.2.

Overall, the remains are highly fragmented. The unidentifiable specimens were generally considerably more fragmentary than the identifiable fraction. Burning is fairly common in the assemblage, with about 40 percent of the total specimens burned. Burning was present on a portion of the NISP for undifferentiated small mammals, undifferentiated large mammals, medium ungulates, *Sylvilagus* sp. (cottontail), *Odocoileus virginianus* or *O. hemionus* (mule deer or white-tailed deer), and indeterminate vertebrates (Table 5.3).

Weathering is uncommon, and a negligible portion of the remains exhibit carnivore or rodent gnawing. The carnivore-gnawed bones seem to have been damaged by a canid, as opposed to a felid or other small carnivore. Roughly one-quarter of the assemblage has evidence of human butchering either in the form of transverse fractures (perpendicular to the long axis of the bone, often found on long bone shafts, ribs, and vertebral sections) or splitting (fractures parallel to the long axis of the bone, often indicative of opening long bone shafts for marrow). Two specimens were worked. One, a distal turkey tibiotarsus, appears to be debitage from the production of beads. The other is a worked long bone portion from a medium ungulate (probably mule or white-tailed deer). Function for this piece cannot be determined, although it may have been a portion of a tool or the remains of tool manufacture.

DISCUSSION

The faunal assemblage recovered from the 3-Up site was overwhelmingly comprised of wild mammals. A few of these, such as hawks, may have been used for something other than food. A few domesticated or

Table 5.2. Minimum number of individuals, by species (all loci combined), from the 3-Up site, LA 150373.

	Minimum Number of Individuals	
Species	No.	Percent
Catostomidae (suckers)	2	4.8
Picidae (woodpecker or flicker)	1	2.4
Callipepla squamata (scaled quail)	1	2.4
Buteo sp. (hawk)	1	2.4
Buteo jamaicensis (red-tailed hawk)	1	2.4
Meleagris gallopavo (turkey)	1	2.4
Thomomys bottae (pocket gopher)	5	11.5
Sciuridae (squirrel or prairie dog)	2	4.8
Dipodomys sp. (kangaroo rat)	1	2.4
Sylvilagus sp. (cottontail)	7	16.7
Lepus californicus (black-tailed jackrabbit)	4	9.5
Odocoileus virginianus or *O. hemionus* (mule deer or white-tailed deer)[a]	9	21.4
Ovis canadensis (bighorn sheep)	2	4.8
cf. *Cervus elaphus* (elk) or large deer	1	2.4
Antilocapra americana (pronghorn)	1	2.4
Canis familiaris or *C. latrans* (dog or coyote)	2	4.8
Canis familiaris (domestic dog)	1	2.4
Total	42	100.0

[a]One deer individual is fetal or neonate, and one is juvenile (<50 percent the size of an adult).

Table 5.3. Presence of burning, by number of individual specimens, by locus, from the 3-Up site, LA 150373.

	Locus A		Locus B		Locus C		Locus F		Locus G		Total	
	n	%	*n*	%	*n*	%	*n*	%	*n*	%	*n*	%
Small mammal	3	7.5	8	2.7	0	0.0	0	0.0	0	0.0	11	3.2
Large mammal	28	70.0	0	0.0	0	0.0	0	0.0	0	0.0	28	38.6
Sylvilagus sp. (cottontail)	0	0.0	2	0.7	0	0.0	0	0.0	0	0.0	2	0.6
Medium ungulate	1	2.5	263	89.8	6	85.7	2	100.0	0	0.0	272	160.3
Odocoileus virginianus or *O. hemionus* (white-tailed or mule deer)	2	5.0	20	6.8	1	14.3	0	0.0	1	100.0	24	43.8
Indeterminate vertebrate	6	15.0	0	0.0	0	0.0	0	0.0	0	0.0	6	1.7
Grand Total	40	100.0	293	100.0	7	100.0	2	100.0	1	100.0	343	100.0

commensal species were present, including turkey and domesticated dog. Large game animals such as mule deer and elk were clearly important. With a significant percentage of the diet based on these animals, the inhabitants of the site, during the 700-year-long occupation, may well have decimated the surrounding populations of deer, elk, pronghorn, and bighorn sheep. As such, hunters would have had to range farther afield to encounter these large ungulates.

A large site catchment area for big game resources may be reflected in the high frequency of appendicular elements from large game identified in this assemblage. Kill site processing behavior is very different for large animals that are killed close to the hunter's home than for game killed greater distances from the place of consumption (Perkins and Daly 1968). When processing large animals some distance from home, hunters often return either with just the prime meat-bearing elements, or they completely butcher the animal, pile the meat inside the skin, and, using the still-attached forelimbs as handles, carry the food back to their home. This has been termed the "schlepp effect" (Perkins and Daly 1968:104).

Borck examined the schlepp effect for Unit 301, Locus A. Of the 19 specimens present in the subassemblage, 17 (89 percent of the total) are from the appendicular skeleton. Outside their utility as schlepping handles, metapodials and phalanges are also often used for awls, punches, fishhooks, and tinklers. Fifteen of the elements (79 percent of the total) are from the forefoot, hindfoot, or foot. This is an overwhelming indication that the schlepp effect was likely responsible for the depositional behavior that created the material assemblage recovered from Unit 301.

This demonstrates that the hunters likely traveled long distances to procure meat. Only two specimens present from the vertebra/rib portion (note that no specimens were present from the head in any of the identifiable species) are deer. These specimens were identified to mule deer (*Odocoileus hemionus*), based on size differentiation between mule deer and white-tailed deer (*O. virginianus*). Today, mule deer continue to be the most common large game animal encountered throughout the Gila region, with elk the second most common ungulate species in the area.

Some of the fragmentary pieces of the faunal material help identify food-processing patterns. A large portion of the skeletal assemblage was small, fragmentary, and burned (either calcined or charred), and many were fractured parallel to the long axis of the skeletal element. This pattern can result from bone marrow exploitation (Outram 2001). Bones are broken and tossed into ceramic jars filled with water. These jars are then brought to a boil to facilitate removal of the marrow.

Boiling fat-rich substances in newly constructed ceramics is a common part of the ceramic production process (Borck 2008). This boiling infuses the ceramic walls with fats, which fill in the spaces between the clay particles, creating an impermeable lining. The ceramics can then be used as water storage containers or to cook liquid foods like stews more effectively. Without this fatty infusion, the water inside the ceramics takes longer to reach boiling temperature (Borck 2008). The extremely burned condition of the bones (instead of only browned) could indicate unattended reuse occurred. Bones already boiled for marrow extraction could be reutilized and overboiled (that is, boiled until the water evaporated) to extract the remaining fats for ceramic sealing. However, it is much more probable that the bones were simply dumped onto the fire after being processed for marrow.

Determining the age of prey species can be useful in establishing site seasonality or in assessing resource stress and intensification. Animal age can be determined by the fusion of long bone ends, which fuse at a known, predictable rate, as well as by tooth eruption and wear, also a well-documented process (Hillson 2005; Purdue 1983; Reitz and Wing 1999; Schmid 1972; Silver 1970). Although no teeth were recovered with which to establish age, long bone ends, as well as the remains of fetal or neonate and juvenile animals, were found at the 3-Up site; these are presented in Table 5.4.

Table 5.4. Ageable elements for deer recovered from the 3-Up site, LA 150373.

Element	Age at Fusion (months)	Unfused	Fused	Percent Unfused
Radius	Fetal or neonate	1	0	100.0
Phalanx I	Fetal or neonate	1	0	100.0
Radius	Juvenile (<50% adult size)	1	0	100.0
Metacarpal	Juvenile (<50% adult size)	1	0	100.0
Early Fusing				
Distal humerus	12–20	0	1	0.0
Proximal radius	5–8	0	1	0.0
Proximal 1st/2nd phalanx	11–20	0	5	0.0
Proximal metapodial	Fetal or neonate	1	2	33.3
Middle Fusing				
Calcaneus	26–29	1	2	33.3
Distal metapodial	26–29	0	1	0.0
Late Fusing				
Distal ulna	26–35	0	2	0.0
Vertebral centrum	35–42	1	0	100.0
Distal radius	N/A	0	2	0.0

Note: Fusion estimate from Purdue 1983.

At least two fetal or neonate mule or white-tailed deer were present in the 3-Up site assemblage. Because mule or white-tailed deer typically give birth in early June (Purdue 1983), the presence of a fetal or neonate individual indicates the site was probably occupied in the late spring or early summer, although it may have been inhabited at other times of the year as well. Also present are one juvenile individual less than half the size of a mature adult. The rest of the fused elements indicate that a few individuals more than two years of age were exploited. Due to the small sample size, little can be said about the degree of resource stress or intensification based on the age of the animals present.

In-depth comparisons for different areas at Mule Creek have not yet been conducted. Such comparisons are hampered, in part, by discrepancies among loci in terms of overall assemblage size. As shown in Table 5.1, Locus B has the largest faunal assemblage (n = 747), followed by Locus A (n = 174). Not surprisingly, these two loci have the most diverse faunal assemblages. All loci contain small, medium, and large mammals that were likely food species. Fish bones are limited to Locus B, and this locus also has most of the bird specimens from the site. Locus A has the only examples of *Antilocapra americana* (pronghorn) and possible *Cervus canadensis* (elk) known from the site; the latter specimen is a fragment of innominate that may be from an elk or a very large deer. Further analysis of the faunal assemblage, as well as comparisons among 3-Up fauna and other sites in the area, may shed light on changing faunal use through time.

CONCLUSIONS

Inhabitants of the 3-Up site utilized several different species of mammals, birds, and fish. Large game, specifically mule or white-tailed deer, contributed meat to the diet, as did small mammals such as cottontail and jackrabbits. Other animals were used for purposes beyond subsistence. A worked turkey long bone indicates beads were produced at the site; a medium ungulate bone was also worked. Domestic dogs were probably kept, as evidenced by dog bones and ungulate bones gnawed by canids. The red-tailed hawk was probably not consumed, particularly since the element recovered was from a wing. Many of the small animal remains, such as the pocket gopher, squirrel or prairie dog, and woodpecker or flicker, may have been intrusive to the site.

CHAPTER 6

CHARRED PLANT MACROREMAINS FROM THE 3-UP AND GAMALSTAD SITES NEAR MULE CREEK, SOUTHWESTERN NEW MEXICO

Michael W. Diehl

Archaeologists from the Archaeology Southwest Mule Creek Archaeological Testing project excavated subsurface deposits at three sites near Mule Creek in western New Mexico. The 3-Up site, LA 150373, and the Gamalstad site, LA 164472, yielded 37 flotation samples and six hand-collected macrobotanical specimens. The macrobotanical assemblages from the sites indicated a primary emphasis on farming, but differed regarding the range of resources represented at each. The assemblages from 3-Up and Gamalstad indicated that nut and fruit masts of acorn/walnuts, juniper berries, pinyon nuts, and walnuts were important secondary resources. In addition, beans, squash/gourd, goosefoot, and pigweed were observed at the 3-Up site.

This report describes the macrobotanical assemblages from the 3-Up and Gamalstad sites, followed by a comparison of those assembalges with Salado assemblages from sites on the Mimbres River, as well as with sites in the lower Tonto Basin.

Based on these preliminary findings, fourteenth through fifteenth century AD occupations in southwestern New Mexico and sub-Mogollon Rim Arizona appear to have shared an emphasis on local crop production. Local preferences, however, prevailed regarding the use of arboreal resources (mesquite pods, nut masts, and juniper fruit), cactus fruit, and agave. Each area—the Mule Creek sites broadly included in the late Mimbres area, the lower Tonto Basin, and the Tucson Basin—have at least one site that was a locus of cotton production or distribution.

PALEOBOTANY OF THE 3-UP, LA 150373, AND GAMALSTAD, LA 164472, SITES

Thirty-seven flotation samples and six hand-collected macrobotanical specimens were collected from the sites. The 3-Up site is represented by 11 samples from extramural trash middens and 11 samples from seven discrete features encountered in subsurface deposits underneath middens. Gamalstad yielded five samples from midden deposits and 10 samples from four features. The general characteristics of the flotation samples are described in Table 6.1. The frequencies of seeds and other reproductive tissues are presented in Table 6.2, and the frequencies of wood charcoals are shown in Table 6.3. Hand-collected macrobotanical specimens are described in Table 6.4.

Eight categories, comprised of seven genera or species of food plants, were observed in the Mule Creek assemblages. As indicated in Table 6.2, these genera/species included three crops (beans, maize, and squash), two crop weeds (goosefoot and pigweed), and three or four arboreal species (acorn/walnut, juniper, pinyon pine, and walnut).

Table 6.1. Inventory of flotation samples from the 3-Up site, LA 150373, and Gamalstad, LA 164472.

Site, Feature No.	FN	Unit	Stratum	Level	Volume (l)	Weight (g)	Modern, Unburned Seeds	Insect Exoskeleton Fragments	Terrestrial Snail Shells
3-Up, LA 150373									
–	264	–	61	4	2.0	16.5	1–50	1–50	1–50
–	61	102	4	4	1.0	24.6	51–100	0	1–50
–	69	103	4	2	2.5	10.	1–50	1–50	1–50
–	86	103	4	4	4.0	24.0	51–100	51–100	0
–	98	104	50	4	4.0	40.2	0	0	1–50
–	107	104	50	3	2.0	27.0	0	1–50	1–50
–	109	105	50	2	2.0	16.4	0	0	0
–	206	107	4	2	3.0	23.1	1–50	0	1–50
–	229	108	4	2	3.0	27.5	1–50	1–50	1–50
–	211	301	50	2	3.0	15.3	0	0	1–50
–	223	301	50	4	4.0	27.2	0	0	1–50
1	2	101	50	2	2.0	15.0	1–50	1–50	0
1	26	101	50	3	3.0	12.4	0	0	0
1	42	101	50	5	2.0	6.8	1–50	1–50	0
2	60	102	50	1	1.0	17.9	1–50	1–50	1–50
4	126	104	50	6	2.0	18.0	0	0	1–50
4	150	104	50	–	2.5	21.7	0	0	1–50
5	139	105	50	4	2.0	38.9	1–50	1–50	1–50
5	192	105	50	6	2.0	14.6	0	0	0
6	191	104	50	1	2.0	11.7	0	0	1–50
8	232	107	50	1	3.0	18.0	0	0	0
9	281	103	50	1	1.0	15.7	0	0	1–50
Gamalstad, LA 164472									
–	443	100	4	2	2.0	6.3	0	0	0
–	120	105	4	2	3.0	34.4	0	0	1–50
–	314	106	4	2	3.0	3.0	0	1–50	1–50
–	324	106	4	4	3.0	30.9	0	0	0
–	351	106	4	6	4.0	24.6	51–100	1–50	1–50
1	444	101	50	4	4.0	39.2	0	1–50	1–50
1	73	102	50	4	4.0	39.0	0	0	1–50
1	86	102	50	6	2.0	10.0	1–50	1–50	1–50
1	97	101	50	6	4.0	32.9	0	0	1–50
1	121	101	50	8	4.0	64.7	1–50	1–50	1–50
2	134	105	30	1	2.0	10.7	0	0	0
2	149	105	30	2	2.0	42.6	1–50	0	1–50
2	172	104	30	2	3.0	40.1	0	1–50	1–50
3	119	102	10	2	4.0	21.5	0	0	1–50
6	163	101	10	2	2.0	25.6	0	0	1–50

Amaranthus sp. (Pigweed; Amaranthaceae)

Pigweed grows throughout Arizona and New Mexico at elevations from 1,000 to 8,000 ft (Brown 1994:122–132; Kearney and Peebles 1973:265–267). In the semidesert grassland that encompasses the vicinity of the Mule Creek sites, pigweed grows most prolifically in floodplains of washes, along roadsides, and on gradual slopes where runoff and slope-washed silt accumulate. Pigweeds typically flower in the summer after season-

Table 6.2. Frequencies of food plant tissues in flotation samples from the 3-Up site, LA 150373, and Gamalstad, LA 164472.

					Crops			Crop Weeds		Arboreal			
Site, Feature No.	FN	Unit	Stratum	Level	Beans	Maize	Squash or Gourd	Goosefoot	Pigweed	Acorn-Walnut	Juniper	Pinyon	Walnuts
3-Up, LA 150373													
–	264	–	61	4	2	3c	0	1	0	0	0	0	0
–	61	102	4	4	0	0	0	0	0	0	0	0	0
–	69	103	4	2	1	3c	0	0	0	0	0	0	0
–	86	103	4	4	0	0	0	0	0	0	0	0	0
–	98	104	50	4	0	4c	0	0	0	1s	0	0	0
–	107	104	50	3	0	1c	0	0	0	0	0	0	0
–	109	105	50	2	0	0	0	0	0	0	0	0	0
–	206	107	4	2	0	1c	0	0	0	0	0	0	0
–	229	108	4	2	0	0	0	0	0	0	0	0	0
–	211	301	50	2	0	1c	0	0	0	0	0	0	0
–	223	301	50	4	0	6c	1r	0	0	0	0	0	0
1	2	101	50	2	0	1k	0	0	0	0	0	0	0
1	26	101	50	3	0	1c	0	0	0	0	0	0	0
1	42	101	50	5	0	0	0	0	0	0	0	0	0
2	60	102	50	1	0	2c	0	0	0	0	0	0	0
4	126	104	50	6	0	3c, 1k	0	0	0	0	0	0	0
4	150	104	50	–	0	5c	0	0	0	0	0	0	0
5	139	105	50	4	0	7c	0	0	0	0	0	1cs	0
5	192	105	50	6	0	0	0	0	0	1s	0	0	0
6	191	104	50	1	0	10c, 1k	0	0	0	1s	0	0	0
8	232	107	50	1	0	5c	0	1	1	0	0	0	0
9	281	103	50	1	0	3c	0	1	0	0	0	0	0
Gamalstad, LA 164472													
–	443	100	4	2	0	1c, 1k	0	0	0	0	0	0	0
–	120	105	4	2	0	1c	0	0	0	0	0	0	0
–	314	106	4	2	0	1c	0	0	0	0	0	0	0
–	324	106	4	4	0	1c	0	0	0	0	0	0	0
–	351	106	4	6	0	1c, 1k	0	0	0	0	1	0	0
1	444	101	50	4	0	1c	0	0	0	0	0	0	0
1	73	102	50	4	0	1c	0	0	0	0	1	0	0
1	86	102	50	6	0	1c	0	0	0	0	0	0	0
1	97	101	50	6	0	6c, 1k	0	0	0	0	0	0	0

Table 6.2. Continued.

Site, Feature No.	FN	Unit	Stratum	Level	Crops			Crop Weeds		Arboreal			
					Beans	Maize	Squash or Gourd	Goosefoot	Pigweed	Acorn-Walnut	Juniper	Pinyon	Walnuts
Gamalstaed, LA 164472 (cont'd.)													
1	121	101	50	8	0	1c	0	0	0	0	0	0	1s
2	134	105	30	1	0	1c	0	0	0	0	0	0	0
2	149	105	30	2	0	2	0	0	0	0	0	0	0
2	172	104	30	2	0	1c	0	0	0	0	0	0	0
3	119	102	10	2	0	0	0	0	0	0	0	1cs	0
6	163	101	10	2	0	5c	0	0	0	0	1	0	0

Notes: c = cupules, cs = cone scale, k = kernel fragment, r = rhind fragment, s = nutshell fragment. Taxa: beans (*Phaseolus vulgaris*), maize (*Zea mays*), squash/gourd (cf. *Cucurbita* sp.), goosefoot (*Chenopodium* sp.), pigweed (*Amaranthus* sp.), acorn/walnut (*Quercus/Juglans* sp.), juniper (*Juniperus* sp.), pinyon (*Pinus edulis*), walnuts (*Juglans* sp.).

Table 6.3. Frequencies of wood charcoal in flotation samples from the 3-Up site, LA 150373, and Gamalstad, LA 164472.

Site, Feature No.	FN	Cottonwood / Willow	Juniper	Oak	Pine	Pine / Juniper	Reed	Saltbush	Unknown
3-Up, LA 150373									
–	264	0	3 (t)	13 (0.2)	0	0	0	0	4 (0.2)
–	61	0	0	16 (0.3)	0	4 (0.2)	0	0	0
–	69	1 (t)	6 (0.2)	6 (0.1)	0	0	0	0	7 (0.1)
–	86	0	0	14 (0.2)	0	6 (0.1)	0	0	0
–	98	0	0	16 (0.2)	0	4 (0.1)	0	0	0
–	107	0	0	14 (0.1)	0	4 (0.1)	0	0	2 (0.1)
–	109	0	0	9 (0.2)	0	4 (0.1)	0	0	0
–	206	0	0	7 (0.1)	0	6 (0.1)	0	0	0
–	229	0	0	2 (0.1)	0	0	0	0	2 (0.1)
–	211	0	0	6 (0.1)	0	13 (0.2)	0	0	1 (t)
–	223	0	0	14 (0.6)	0	2 (0.2)	0	0	4 (0.1)
1	2	0	3 (t)	2 (t)	0	0	1 (t)	0	1 (t)
1	26	0	0	17 (0.2)	0	2 (t)	1 (t)	0	0
1	42	0	0	0	5 (t)	0	0	0	5 (t)
2	60	0	0	14 (0.1)	0	6 (t)	0	0	0
4	126	0	0	16 (0.1)	0	4 (t)	0	0	0
4	150	0	0	16 (0.6)	1 (0.1)	1 (t)	0	2 (0.1)	0
5	139	0	0	13 (1.6)	0	3 (0.5)	0	0	4 (0.2)
5	192	0	0	19 (0.4)	0	0	0	0	1 (t)
6	191	0	0	17 (0.4)	0	3 (0.1)	0	0	0
8	232	0	0	3 (t)	0	3 (t)	0	0	0
9	281	0	0	19 (1.7)	0	1 (t)	0	0	0
Gamalstad, LA 164472									
–	443	0	0	3 (0.1)	0	0	0	0	0
–	120	0	0	2 (t)	0	0	0	0	0
–	314	0	0	8 (0.1)	0	0	0	0	0
–	324	0	0	6 (0.1)	0	6 (0.2)	0	0	0
–	351	0	0	6 (t)	0	10 (t)	0	0	4 (t)

Table 6.4. Hand-collected macrobotanical specimens from the 3-Up site, LA 150373, and Gamalstad, LA 164472.

Site	Feature No.	FN	Unit	Stratum	Level	Identification	Weight (g)
3-Up	7	253	206	10	2	*Juniperus* sp. (juniper) wood charcoal	3.2
Gamalstad	3	201	102	40	1	*Quercus* sp. (oak) wood charcoal	2.1

al rains promote conditions favorable for growth and ripen in late summer to early fall. Moerman (1998:65) noted that, wherever used, the ripe seeds were typically ground into a meal and combined with other ingredients, or they were cooked whole in stews.

Atriplex sp. (Saltbush; Chenopodiaceae)

Saltbush is a common woody shrub at elevations below 6,000 ft throughout Arizona and New Mexico (Kearney and Peebles 1973). Its growth habit, a many-branched shrub with thin, brittle branches, makes it an ideal source of kindling. Moerman (1998:115–117) documented the use of the wood ash as a leavening agent or soap and the use of wood in tools or poultices for various ailments.

Chenopodium sp. (Goosefoot; Chenopodiaceae)

Goosefoot (*C. fremontii*) commonly occurs at elevations from 2,500 through 9,000 ft, and it flowers from June through September in southeastern Arizona and southwestern New Mexico (Kearney and Peebles 1973:253). As many researchers have noted, the greens were consumed by Native Americans in the American Southwest as a potherb, and the seeds were parched, winnowed, and used in a variety of recipes (Minnis 1991:240; Moerman 1998:154–157; Rea 1997:202–203).

The consumption of modest amounts of pigweed greens in a basal maize-bean diet can dramatically improve the total quality of the diet (Food and Agricultural Organization of the United Nations [FAO] 1992:131). The inclusion of goosefoot in preparations involving the common bean (*Phaseolus* sp.) can extend the shelf life of cooked food (Logan et al. 2004).

cf. *Cucurbita* sp. (Squash or Gourd; Cucurbitaceae)

One possible squash or gourd rind fragment was observed in a sample from the 3-Up site. The fragment was too small to identify to species.

Juniperus sp. (Juniper; Cupressaceae)

Juniper seeds and wood were found in several samples, and these are presumed to be by-products from the consumption of the fruit. Juniper is found throughout Arizona and New Mexico at elevations ranging from roughly 3,000 to 8,000 ft, depending on the taxon (Kearney and Peebles 1973:58–60). Juniper wood charcoal was observed in five samples. Documented uses include the consumption of the fruit as food alone or with meat, the needles in a tea, and the wood for fuel, construction, dye, and for tools (Adams 1988:285–290; Moerman 1998:285–286).

Quercus sp. (Oak; Fagaceae)

Possible acorn shell fragments (acorn/walnut) were observed in three samples. Oak grows prolifically throughout the Southwest, including at elevations in Arizona and New Mexico generally above 2,000 ft where water permits (Kearney and Peebles 1973:216–219). Oak wood charcoal was observed in most samples and was, by both frequency and ubiquity, the dominant wood charcoal in the Mule Creek paleobotanical assemblage. Oak was potentially useful in house construction, in making tools, and as fuel.

Phragmites sp. (Common Reed; Gramineae)

Common reed grows around the world in floodplain contexts that are frequently or constantly saturated (Kearney and Peebles 1973:89). Prehistoric uses of this plant are legion, including (among other uses) the manufacture of arrow foreshafts, basketry, pipe stems, prayer sticks (among the Navajo), reed cigarettes, and roof matting (Moerman 1998:394–395). When dried, common reed was also undoubtedly useful as kindling. Reed fragments were observed in two samples from 3-Up and in three samples from Gamalstad.

Zea mays (Maize; Gramineae)

Maize is the well-known cultigen that originated in Mexico, which was transmitted to southern Arizona by 2200 BC. For its first 2,000 years of use, it was one of many wild and cultivated resources that were extensively harvested. Its ancient occurrence in New Mexico is known from Bat Cave (Wills 1988), at the Old Corn site near Zuni pueblo (van West 2009), and, of more recent age and nearer to the Mule Creek sites, along U.S. Highway 90 at the Beargrass, LA 121158; Forest Home, LA 78089; and Wood Canyon, LA 99631, sites (Turnbow 2000).

Although early Southwestern varieties offered poor yields (Diehl 1995), by the eighth century AD, high-yield flour-kernelled hybrids were available in the Southwest (Adams 1994; Galinat 1988; Upham et al. 1987, 1988). Their introduction promoted increased reliance on crops in the Mogollon region (Diehl 1996).

Juglans sp. (Walnut; Juglandaceae)

Walnut is endemic to riparian zones throughout the Southwest (Szaro 1989). It grows as a tree at elevations from 3,500 to 7,000 ft in Arizona and New Mexico, as well as in the form of a tall tree (Kearney and Peebles 1973:213–214). Moerman's (1998:280–281) overview of ethnohistorical uses of *J. major* (the taxon that grows most prolifically in New Mexico) mentions the use of wood in particular in only one case—the Meskwakie. Regardless, walnut wood has obvious and well-known potential for use in making tools and as a fuel.

Phaseolus vulgaris (Common Bean; Leguminosae)

Common beans were observed in two flotation samples from the 3-Up site. Beans, in conjunction with maize and squash, form the agricultural triad of traditional Southwestern subsistence economies (Ford 1981). Beans are a particularly good complement for maize, because they contain amino acids maize lacks, and they are generally high in protein (FAO 1992). Their presence in the project flotation samples is almost certainly attributable to their consumption as food.

Pinus edulis (Pinyon Pine; Pinaceae)

A single pinyon pine nut hull was found in one sample each from the 3-Up and Gamalstad sites. There is widespread ethnographic evidence for the consumption of pine nuts as food. In Arizona and New Mexico, *Pinus edulis* occurs at elevations from 4,000 to 7,000 ft. Pinyon pines have a two-year reproductive cycle, requiring good moisture in both years to produce adequate nut harvests (Krugman and Jenkinson 1974). Other ethnographically known functions include the use of the wood for making tools, in house construction, and as fuel, and pine needles and pitch as remedies for various ailments (Moerman 1998:406–408).

Pinus/*Juniperus* sp. (Pine or Juniper; Pinaceae or Cupressaceae)

Small fragments of gymnosperm wood charcoal, with narrow, well-defined growth rings and numerous rays and lacking resin ducts, were observed in most samples. Due to the small size of the fragments, the absence of resin ducts on any given one of these was not sufficient grounds to assign them to genus *Juniperus*.

Populus sp. / *Salix* sp. (Cottonwood or Willow; Salicaceae)

Cottonwood and willow thrive in riparian contexts throughout the Southwest. Their woods are indistinguishable using simple optical microscopes. Although these are not the most durable varieties of wood, they are one of the most commonly encountered kinds of wood in archaeological deposits. Their high frequency is probably due to the fact that they are among the most abundant and prolific tree species along major Southwestern drainages and/or because the trunks are very straight. Cottonwood/willow was observed in only one sample from 3-Up.

FOOD PRODUCTION AND FORAGING AT THE MULE CREEK SITES

The ubiquities of charred plant tissues at the 3-Up and Gamalstad sites are described in Table 6.5, by occupation phase. Here, the ubiquity is given by the formula $U_{taxon} = n\text{taxon}/n\text{samples}$, where U_{taxon} is the ubiquity, *n*taxon is the number of samples in which the taxon was present, and *n*samples is the number of samples that contained at least one charred seed, nutshell fragment, or any squash or agave tissue. Agave was not present in the Mule Creek site samples, but the occurrence of any part of agave such as leaf tissue or caudex would have been noted. Further, the ubiquity of other taxa in other sites in the current study is based on the number of features rather than the number of samples in which a taxon occurred. The Mule Creek sites are unusual

Table 6.5. Ubiquities of food plant tissues at the 3-Up site, LA 150373, and Gamalstad, LA 164472.

Site	*n*[a]	Acorn-Walnut	Beans	Goosefoot	Juniper	Maize	Pigweed	Pinyon	Squash or Gourd	Walnuts
3-Up (all)	22	0.14	0.09	0.14	0.00	0.73	0.05	0.05	0.05	0.00
3-Up, Locus B (Kayenta enclave)	11	0.18	0.09	0.09	0.00	0.73	0.00	0.09	0.00	0.00
3-Up, Locus C (Cliff phase Salado)	5	0.00	0.00	0.20	0.00	1.00	0.20	0.00	0.20	0.00
Gamalstad (multicomponent/ Cliff phase Salado)	15	0.00	0.00	0.00	0.20	0.93	0.00	0.07	0.00	0.07

[a]Number of samples containing at least one charred seed or maize cupule.

in this discussion because most of the samples are from test units or features; the other sites are represented exclusively by samples in features or within houses.

Samples from different levels within test units in trash middens may represent different depositional events; in contrast, samples from within pithouse fill, or within a feature, probably represent a single depositional event. Therefore, multiple samples from middens are more likely, in the view of the author, to be analytically independent sampling events of the overall prehistoric food selection regime. In contrast, multiple samples from within a single pithouse hearth or pit, or from a single level of pithouse fill, probably represent redundant samplings of the same depositional event.

The difference becomes important should one wish to compare, statistically, the ubiquities of a taxon at different sites. All statistical tests assume that each observation is independent of the others, and multiple samples from an intramural feature probably do not satisfy that condition. Although the sample sizes, in terms of number of observations, do not support statistical analysis for the current study, proper determination of the ubiquity scores here facilitates future research.

Following common practice among paleobotanists, only charred plant remains are considered in Table 6.5. With very few exceptions, in open-air sites, unburned plant remains tend to rot or be consumed by insects or animals; charred plant remains are, by contrast, almost indestructible because they are not consumed by bacteria, insects, or birds. It follows that when one encounters non-charred seeds and plant tissues in archaeological sites, they are likely of recent (modern) origin introduced by plants growing in the vicinity of the site (Miksicek 1987; Minnis 1981).

Discussion

The Mule Creek project assemblages described in Table 6.5 reflect a subsistence regime focused on a narrow range of resources, the most important of which was maize (*Zea mays*). Maize ubiquity ranged from 0.73 in the 3-Up site samples in the Kayenta enclave in Locus B, to 1.00 in the Cliff phase Salado component in Locus C. Maize also occurred in most ($U_{maize} = 0.93$) Gamalstad Cliff phase samples.

Other crops included squash or gourd tissues in 3-Up Locus C ($U_{squash} = 0.20$) and beans in 3-Up Locus B ($U_{beans} = 0.22$). Goosefoot and pigweed were observed only in samples from the 3-Up site. They are moderately represented with ubiquities that range from 0.09 to 0.20; moderate to high ubiquities of these genera are expected among people who are otherwise highly dependent on crops, because these wild taxa thrive on the margins of cultivated fields and are recognized as an important secondary resource both in ethnographic reviews (Moerman 1998) and in most archaeological reports from Arizona and New Mexico.

The third component of the food procurement regime in the Mule Creek area includes arboreal resources of acorns, juniper berries, pine nuts, and walnuts.

The observed taxa are expected to offer the highest energy return rates (as compared to efforts required to obtain them) in the areas surrounding the Mule Creek project sites. Thus, it is possible that the food procurement activities at 3-Up and Gamalstad were narrowly focused on only the most productive or most reliable food resources in the area, namely, crops, crop weeds (plants that grow in dense stands on the margins of cultivated fields), and arboreal resources. Some productive species that are commonly observed in prehistoric deposits were absent; for example, no cactus seeds, agave tissues, or yucca fruit remnants were observed.

The limited variety in the Mule Creek assemblages may be related to the sampling effort dedicated to excavating middens (other resources may have been processed or disposed of in intramural contexts) or to the relatively small numbers of samples from each site and component. Future excavations that might include substantial efforts in intramural contexts might result in the collection of more taxa; however, if the initial impression given here remains empirically accurate after future excavations, one must conclude that the occupants of the 3-Up and Gamalstad sites were peculiarly narrowly focused in their subsistence efforts, at least regarding the use of plants.

PLANT REMAINS IN SALADO CONTEMPORARIES OF THE LOWER MIMBRES, LOWER TONTO, AND TUCSON BASINS

Systematically collected paleobotanical assemblages from Cliff phase sites or their contemporaries are available from the Disert, Janss, and Stailey sites in the Mimbres Valley (Minnis 1986; Nelson and LeBlanc 1986), the Gila phase Schoolhouse Point Mound, AZ U:8:24 (ASU) (Dering 1996; Lindauer 1996), AZ U:4:295 (ASU) (Dering 1997; Oliver 1997a), and Indian Point site, AZ U:4:296a (ASU) (Dering 1997; Oliver 1997b) in the lower Tonto Basin, Arizona, and the Tucson phase Yuma Wash, AZ AA:12:122 (ASM)/ AZ AA:12:311 (ASM)/AZ AA:12:312 (ASM), and Zanardelli, AZ BB:13:1 (ASM), sites in the Tucson Basin, Arizona (Diehl 2009, 2016). These sites provide a basis for comparison with the Mule Creek sites reported here. Although other Salado sites have been excavated, most, such as Dinwiddie near Cliff, New Mexico (Lekson 2002), were excavated before archaeologists systematically collected paleobotanical data.

The ubiquities of all identified charred seed or reproductive tissue taxa from the Mule Creek sites' Cliff phase components and their contemporaries in the Tonto and Tucson Basins of Arizona and the lower Mimbres Valley of New Mexico are presented in Table 6.6. In contrast with the Mule Creek project samples, some other Salado sites have yielded a wide range of plant remains of varying economic value. Some, such as tobacco (*Nicotiana* sp.), loco (*Astragalus* sp.), morning glory family (Convolvulaceae), and beeweed (*Cleome* sp.), probably lacked value as food but were useful for medicinal or ceremonial purposes (see Moerman 1998 for discussions of the ethnographically documented use of each genus). Most were useful as food, but to varying degrees.

Crops, agave and cacti, crop weeds, and arboreal resources generally provide the best energetic returns for the effort required to obtain them (Diehl and Waters 2006), while low-density weeds and wild grasses tend to provide relatively low-energy returns and may have had value as famine foods in the time of crop failure (see Minnis 1991), rather than being regularly consumed as a dietary staple.

Thirty-four kinds of plant tissues are observed among the assemblages reviewed in Table 6.6. For this discussion, the plants have been grouped into six categories. Crops are any domesticated plant, including maize, beans, squash, and cotton. To use them required deliberate land-clearing, planting, weeding, and, in the case of cotton, irrigation. These are generally the best resources regarding the amount of energy gained from their use, because they offer relatively high caloric yields and because the timing and location of their availability is controlled.

Crop weeds include cheno-ams and tansy mustard-peppergrass; these two categories subsume all observations of cheno-ams, goosefoot (*Chenopodium* sp.), or pigweed (*Amaranthus* sp.) into one category (with the ubiquity based on the presence of any of those taxa) into the cheno-ams, and all observations of tansy mustard (*Descurainia* sp.) or peppergrass (*Lepidium* sp.). These are commonly observed in dense stands along the margins of agricultural fields. Although they do not yield as much nutrition for the effort required to obtain them, crop weeds can typically provide moderately high yields because they thrive as commensal weeds alongside crops. One could argue that the wild grass *Sporobolus* sp. (dropseed grass or sacaton grass) should be included among the crop weeds, because dropseed grass can occur naturally in very dense stands. It tends,

Table 6.6. Comparative ubiquities of food plant taxa from Cliff, Gila, and Tucson phase sites in Arizona and New Mexico.

		Crops				Crop Weeds		Agave and Cacti					Low-density Weeds									Arboreal Resources										Wild Grasses			
	n	*Phaseolus* sp. (beans)	*Cucurbita* sp. (squash or gourd)	*Gossypium hirsutum* (cotton)	*Zea mays* (maize)	*Chenopodium*/*Amaranthus* sp. (cheno-am)	*Descurainia*/*Lepidium* sp. (tansy mustard or peppergrass)	*Agave* sp. (agave, tissue)	*Carnegiea gigantea* (saguaro)	*Echinocereus* sp. (hedgehog cactus)	*Opuntia* sp. (prickly pear, seeds)	*Opuntia* sp. (cholla, buds)	*Astragalus* sp. (loco)	*Cleome* sp. (beeweed)	Convolvulaceae (morning glory family)	*Eschscholtzia* sp. (prickly poppy)	Helianthae (sunflower subfamily of Compositae)	*Portulaca* sp. (purslane)	*Nicotiana* sp. (tobacco)	*Polygonum* sp. (smartweed)	*Sphaeralcea* sp. (globemallow)	*Acacia* sp. (acacia)	*Arctostaphylos* sp. (manzanita)	*Atriplex* sp. (saltbush)	*Celtis* sp. (hackberry)	*Juglans* sp. (walnut, shell fragments)	*Juniperus* sp. (juniper)	*Prosopis* sp. (mesquite)	*Pinus edulis* (pinyon pine, cone scale or nutshell fragment)	*Quercus*/*Juglans* sp. (acorn/walnut, shell)	*Simmondsia* sp. (jojoba)	Gramineae (grass family)	*Bouteloua* sp. (grama)	*Hordeumpusillum* (little barley)	*Sporobolus* sp. (dropseed)
Cliff Phase (New Mexico)																																			
3-Up, Locus C	5	0	0.20	0	1.00	0.20	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Disert	13	0.05	0.05	0.24	0.86	0.71	0.05	0	0	0.05	0	0	0	0.05	0	0	0.05	0.62	0	0	0	0	0	0	0	0.05	0.24	0	0	0	0	0.05	0.05	0	0.05
Gamalstad	15	0	0	0	0.93	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.07	0.20	0	0.07	0	0	0	0	0	0
Janss	13	0	0	0	0.85	0.46	0.08	0	0	0.08	0	0	0	0	0.08	0	0	0.08	0	0	0	0.08	0	0	0	0	0.46	0	0	0	0	0	0.08	0	0
Stailey	3	0	0	0	1.00	0.33	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.33	0	0	0	0	0.67	0	0	0
Gila Phase (Arizona)																																			
Schoolhouse Point	25	0.16	0	0.24	0.60	0.08	0.08	0.32	0.04	0.04	0.12	0.08	0	0.04	0	0.04	0	0.04	0.08	0	0.12	0	0.04	0	0.08	0.04	0	0.04	0	0.04	0.08	0.04	0	0.16	0
Indian Point	17	0.06	0	0.24	0.53	0.41	0.06	0.47	0.06	0	0.06	0.12	0.06	0	0	0	0	0	0	0	0.06	0	0	0.06	0	0	0	0.06	0	0	0	0.06	0	0.41	0.06
AZ U:4:295(ASM)	12	0	0	0	0.25	0	0	0.25	0	0.17	0	0	0	0	0	0	0	0	0	0	0.17	0	0	0	0.08	0	0	0	0	0.08	0	0	0	0.33	0
Tucson Phase (Arizona)																																			
Yuma Wash	6	0.17	0	0 (p)	0.67	0.17	0	0	0	0.17	0	0	0	0.17	0	0.17	0	0	0	0	0	0	0	0	0	0	0	0.33	0	0	0	0	0	0	0
Zanardelli	19	0	0.05	0.11	0.63	0.26	0.16	0.26	0.11	0.16	0	0	0.05	0	0	0	0	0	0	0.05	0	0	0	0.21	0	0	0	0.42	0	0	0	0	0	0	0

(p) = Cotton seeds and boll tissue fragments were present in large quantities in several cremations.

however, not to grow in dense stands on the margins of floodplain fields, in part, because competition from goosefoot, pigweed, and tansy mustard crowds out dropseed grass.

Agave and cacti include any of the cacti and agave and would have included yucca had any been observed. These are wild plants that tend to grow away from agricultural fields, but that produce relatively good energy returns for the effort required to obtain them. The best among these was probably saguaro cactus, although that taxon was (and is) geographically restricted to the Tucson Basin and lower Tonto Basin sites in Table 6.6. Agave and cacti can produce energy returns competitive with agricultural crops, but they are less controllable and require more monitoring overall. Further, their harvest season (as with saguaro) can be brief due to extensive competition from wild animals and birds.

Low-density weeds are poor stuff regarding energy returns, because these plants do not typically occur in dense stands and each plant does not generally yield large quantities of seeds (as compared with, for example, cheno-ams or tansy mustard). Seeds of low-density weeds were likely gathered in baskets and parched and ground in the same fashion as crop weeds, but they were used less frequently. Purslane (*Portulaca* sp.) is worthy of special note due to the likely use of its vegetal tissue as a potherb.

Arboreal resources can produce very good energy returns, similar to yields obtained from crops. More often, however, the yields of nut-masts and juniper berries are moderate, because they are highly sensitive to amounts of seasonal precipitation. Their use required extensive monitoring to identify stands that were likely to produce good yields in any given year and to allow a successful harvest in the face of competition from animals and birds.

The wild grasses are the final category in Table 6.6. Wild grasses tend, on the whole, to be poor resources, because the effort required to harvest and prepare enough seeds to make a meal uses almost as many calories as the prepared food yields on consumption (Cane 1989). Sacaton or dropseed grass provides an occasional exception, as did, possibly, little barley and ricegrass (*Oryzopsis* sp., not observed in any assemblage but native to Arizona and New Mexico).

Discussion

Agricultural crops were clearly the most regularly sought-after and used food plants in the subsistence economies among the contemporaries of the Mule Creek project's Cliff phase sites. Maize ubiquities are high at all sites, ranging from 0.60 at the Gila phase Schoolhouse Point Mound site in the lower Tonto Basin to 1.00 at the Stailey site in the Mimbres valley and at the 3-Up site (Locus C) near Mule Creek.

Interestingly, maize ubiquities at Tucson Basin sites are comparable to that of Schoolhouse Point Mound in the Tonto Basin. The availability of agave, prickly pear cactus, saguaro cactus, and mesquite pods in these areas may have allowed a greater amount of dietary flexibility than could be found near the Mule Creek and Mimbres Valley sites. Agave/cactus ubiquities peaked at $U_{saguaro} = 0.17$ at the Yuma Wash site near Tucson, at $U_{agave} = 0.26$ and $U_{saguaro} = 0.16$ at the Zanardelli site, and at Schoolhouse Point Mound, agave and prickly pear were well represented ($U_{agave} = 0.32$, $U_{prickly\ pear} = 0.12$). In contrast, no agave was observed in the lower Mimbres Valley Cliff phase sites nor in 3-Up Locus C or Gamalstad. Cacti were only observed in the lower Mimbres sites, and there only infrequently.

Arboreal resource use seems to have been regionally specific. Although mesquite is now present in the Mimbres Valley and along Mule Creek, it was absent in the Mimbres Valley and Mule Creek Cliff phase sites. It was, in contrast, abundant at the Schoolhouse Point, Yuma Wash, and Zanardelli sites in Arizona. Juniper was very abundant among the Mule Creek and Mimbres Valley sites and absent from the lower Tonto Basin and Tucson Basin sites, despite the abundant availability of juniper on the margins of the Tucson and Tonto Basins.

Finally, it is interesting that although most sites lacked cotton, each region is represented by at least one site that yielded cotton seeds. In the Tucson Basin, the Tucson phase component at Yuma Wash lacked cotton, although it was present in large quantities in several burials, and it was also present at the Zanardelli site. Cotton was present in 24 percent of the features at Schoolhouse Point in the lower Tonto Basin. Finally, although absent from Mule Creek sites, cotton could have been obtained from the Disert site in the Mimbres Valley. Broadly speaking, each region seems to have had at least one production or distribution center for cotton. This observation may be important for understanding the intraregional and interregional economic dynamics of the fourteenth and fifteenth centuries AD among these sites.

DIRECTIONS FOR FUTURE RESEARCH

Paleobotanical research may ultimately be able to address issues of ethnicity or geographic origin of late prehistoric migrants. For that to happen, there would have to be preceding regionally specific food preferences that lead to the selective use of some resources and the selective non-use of others. For example, if it becomes apparent that the occupants of Salado sites in some areas ignored agave despite widespread local availability, and if preceding prehistoric populations made extensive use of agave, one might infer that the Salado occupants did not share an ethnic preference for agave use. They might, in turn, be reasonably construed to have come from regions where there was little preceding prehistoric emphasis on agave.

To make such assessments, ongoing Salado research should be incorporated into a larger database to systematically assess the empirical evidence for region-specific food preferences within Arizona and New Mexico. Ultimately, the work must also incorporate evidence, as it becomes available, from Sonora and Chihuahua as well, as Salado occupations are not geographically restricted to the confines of the United States. Each region appears to have had a local preference for the kinds of arboreal resources that were used. Further research will ultimately reveal if the lack of mesquite seeds and pods in Cliff phase sites in southwestern New Mexico indicates the existence of a regional food preference, or is instead either a statistical consequence of the relatively small number of excavated Salado sites and features in the area.

A second, more likely outcome of paleobotanical research will be the documentation of aspects of the political economy of food and cotton use during late prehistoric times. Based on the results presented here, cotton may have been grown in regional production centers and locally distributed throughout southwestern New Mexico and southern and central Arizona. It has not yet been determined if regions as broad as the lower Tonto Basin or the Mimbres Valley would have required only one local cotton production and distribution center or if sufficiently large population concentrations existed to support multiple centers (as seems to have been the case in the Tucson Basin). Agave may be another resource that was produced or distributed in regional centers. Tracking the production of these commodities may ultimately provide another window on regional and interregional socioeconomic ties that is currently viewed primarily through the glass of ceramic types and production localities.

CHAPTER 7

TESTING AT GAMALSTAD, LA 164472

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INTRODUCTION

As part of the 2008 and 2009 Preservation Archaeology Field Schools, Archaeology Southwest and Hendrix College conducted limited testing at the newly recorded site of Gamalstad, LA164472 or NM S:13:10 (ASM). This is a multicomponent pueblo situated on a low rise at the confluence of Tennessee and Mule Creeks (Figure 7.1). The area has been heavily impacted by mechanical excavation and subsequent backfilling of exposed cultural features. Thus, it is difficult to identify obvious wall alignments or other features on the surface of the site. Available ceramic and architectural evidence suggests the site has Late Pithouse period, Classic Mimbres, and Cliff phase occupations. Six 1-m by 2-m test units and one 1-m by 1-m test unit were excavated at the site (Table 7.1).

EXCAVATION UNIT DESCRIPTIONS

Unit 100 is the only unit at Gamalstad excavated in 2008. This was a 1-m by 2-m unit located in the southwestern portion of the site. The unit was excavated in two 10-cm levels following the surface slope and a final truncated (3-cm) level ending in the sterile substrate. Artifact density peaked in the first 10-cm level. Due to comparatively low artifact density, scarcity of charcoal, and shallow depth, the excavators considered this deposit to be sheet trash. Rodent disturbance was present but was minimal compared with other units at the site. Dark grayish-brown fill gave way to reddish or orangish sterile. The small collection of ceramics from Unit 100 shows a high proportion of Cliff phase ceramic types compared with most other units (Table 7.2). Exception Unit 103, Unit 100 contains the clearest evidence of a discrete Salado component with little mixing of earlier Mimbres material.

Units 101 and 102 were located in the northeastern portion of the site. Rodent disturbance, dark sediment, and a high artifact density were visible on the site surface in this area. This presumed midden deposit was labeled Feature 1. In Unit 101, eight 10-cm levels of dark grayish-brown, artifact-rich fill were removed, with the first seven levels excavated following the slope of the modern ground surface (Figure 7.2). The eighth level ended at sterile substrate in the southern half of the unit and in pit fill (Feature 6) in the northern portion of the unit. A dense concentration of artifacts and unworked stone sloped from south to north through Levels 6–8, with patches of ash and charcoal appearing in Levels 7 and 8. Feature 6 fill contained patches of ash and chunks of adobe, with somewhat lower artifact density than in levels above the feature. Heavy rodent disturbance appeared throughout the unit.

The exact nature of this pit feature in Unit 101 remains in question. The excavators identified possible remnants of a prepared surface in addition to the remains of a thick coat of plaster along the pit wall and a posthole, about 8 cm in diameter, immediately outside the pit. Except the posthole, no interior features were uncovered and the roughly 0.5 m^2 of exposed feature provides no way to estimate total feature size. The very small sample of decorated ware recovered from Feature 6 supports a Late Pithouse period date, and the most likely interpretation is that the exposed feature is a portion of a much larger pithouse. The 13-cm elevation difference between the possible surface and the sterile substrate within the pit feature suggests a possible

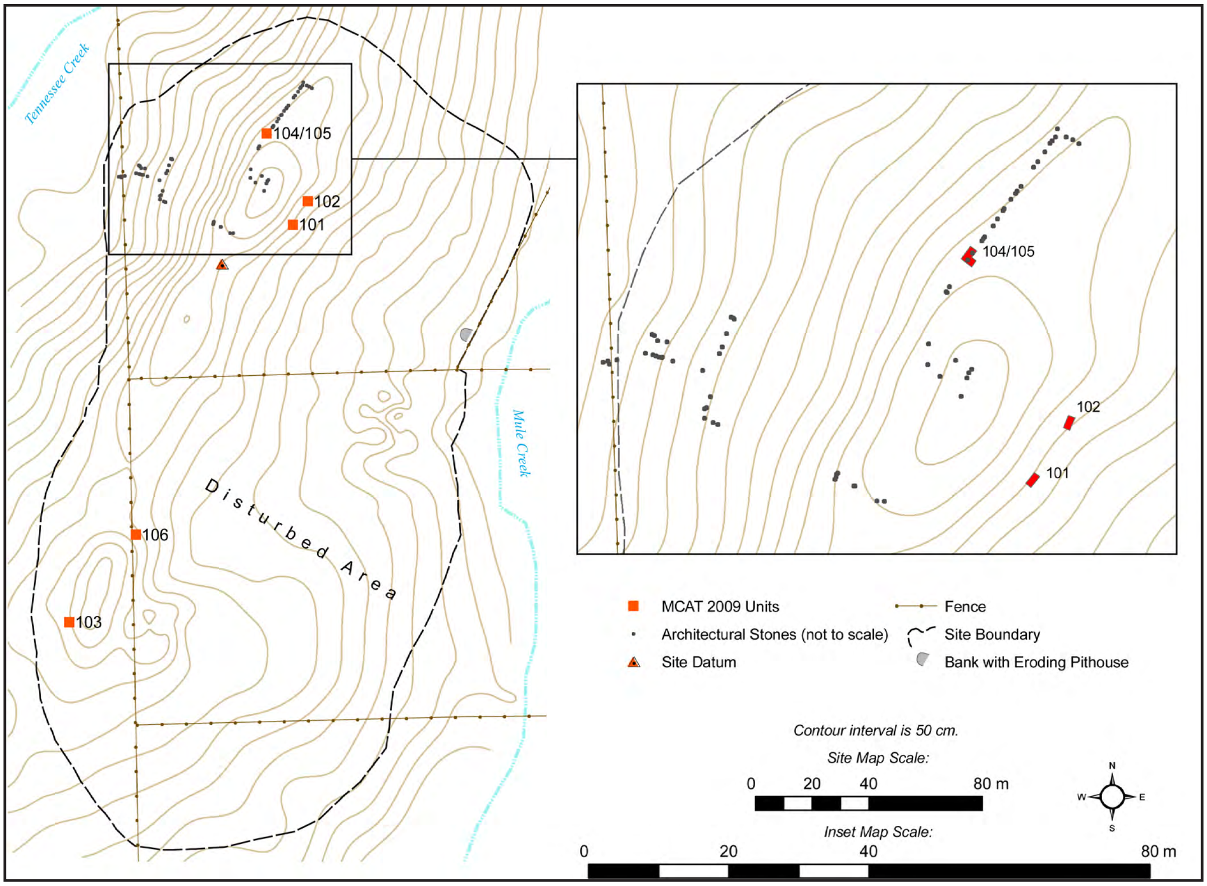

Figure 7.1. Gamalstad, LA 164472, plan view showing locations of excavation units and major features.

Table 7.1. Test excavation units at Gamalstad, LA 164472.

Unit No.	Size (m)	Maximum Depth (m)	No. of Levels	Context	Feature Nos.
100	1.0 by 2.0	0.26	3	Sheet trash	–
101	1.0 by 2.0	1.00	10	Heavily mixed midden, pit structure	1, 6
102	1.0 by 2.0	0.92	9	Heavily mixed midden, architectural feature	1, 3
103	1.0 by 2.0	0.43	4	Sheet trash or shallow middle	4
104	1.0 by 2.0	0.22	2	Architectural alignment and sheet trash	2
105	1.0 by 1.0	0.26	3	Features associated with architectural alignment and sheet trash	2, 5
106	1.0 by 2.0	0.70	7	Sheet trash	–

reflooring event. The depth of Feature 6, particularly the surface remnants within the feature, is quite shallow relative to the depth of the sterile substrate outside the feature (the difference is about 24 cm, or 11 cm at the depth of the floor). While the surface would have been higher than the sterile substrate when the feature was constructed, it seems likely that this feature was rather shallow.

In Unit 102, six 10-cm levels of dark gray brown fill were excavated following the slope of the ground surface before the excavation encountered an architectural feature, Feature 3. As in Unit 101, the upper levels of fill were artifact rich and heavily disturbed by rodent burrows. In the seventh level below surface, a wall, oriented roughly northeast-southwest, running through the southeastern portion of the unit, was exposed. Remnants

Table 7.2. Decorated ceramics, by locus, from Gamalstad, LA 164472.

	Unit 100		Unit 101		Unit 102		Unit 103		Unit 104		Unit 105		Unit 106		Total	
	n	%	*n*	%	*n*	%	*n*	%	*n*	%	*n*	%	*n*	%	*n*	%
Maverick Mountain Polychrome	–	–	–	–	–	–	1	3.4	–	–	–	–	–	–	1	0.2
Undifferentiated Maverick Mountain Series	2	18.2	–	–	–	–	3	10.3	–	–	–	–	1	2.0	6	1.3
Total Maverick Mountain Series	*2*	*18.2*	–	–	–	–	*4*	*13.8*	–	–	–	–	*1*	*2.0*	*7*	*1.5*
Gila Polychrome	–	–	–	–	–	–	–	–	–	–	1	11.1	–	–	1	0.2
Cliff Polychrome	–	–	–	–	1	0.5	1	3.4	–	–	–	–	–	–	2	0.4
Tonto Polychrome	–	–	–	–	1	0.5	–	–	–	–	–	–	–	–	1	0.2
Dinwiddie Polychrome	–	–	1	0.6	–	–	–	–	–	–	–	–	–	–	1	0.2
Undifferentiated Salado Polychrome	5	45.5	5	3.1	8	4.1	11	–	1	11.1	4	44.4	5	10.0	39	8.5
Total Salado Polychrome	*5*	*45.5*	*6*	*3.8*	*10*	*5.2*	*12*	*41.4*	*1*	*11.1*	*5*	*55.6*	*5*	*10.0*	*44*	*9.6*
Cliff White-on-red	–	–	–	–	–	–	1	3.4	–	–	–	–	1	2.0	2	0.4
Undifferentiated White-on-red	3	27.3	–	–	1	0.5	1	3.4	–	–	–	–	1	2.0	6	1.3
Total White-on-red	*3*	*27.3*	–	–	*1*	*0.5*	*2*	*6.9*	–	–	–	–	*2*	*4.0*	*8*	*1.7*
Mogollon Red-on-brown	–	–	2	1.3	5	2.6	–	–	–	–	–	–	1	2.0	8	1.7
Three Circle Red-on-white	–	–	6	3.8	3	1.6	–	–	–	–	1	11.1	4	8.0	14	3.0
Boldface Black-on-white	1	9.1	26	16.4	12	6.2	1	3.4	1	11.1	1	11.1	6	12.0	48	10.4
Mimbres Transitional Black-on-white	–	–	14	8.8	14	7.3	–	–	–	–	–	–	3	6.0	31	6.7
Mimbres Classic Black-on-white	–	–	17	10.7	21	10.9	1	3.4	–	–	–	–	1	2.0	40	8.7
Undifferentiated Mimbres Black-on-white	–	–	60	37.7	79	40.9	3	10.3	3	33.3	2	22.2	16	32.0	163	35.4
Total Mogollon/Mimbres	*1*	*9.1*	*125*	*78.6*	*134*	*69.4*	*5*	*17.2*	*4*	*44.4*	*4*	*44.4*	*31*	*62.0*	*304*	*66.1*
Undifferentiated Cibola White Ware	–	–	–	–	2	1.0	–	–	–	–	–	–	–	–	2	0.4
El Paso Polychrome	–	–	–	–	2	1.0	–	–	–	–	–	–	–	–	2	0.4
Ramos Polychrome	–	–	–	–	5	2.6	–	–	–	–	–	–	–	–	5	1.1
Undifferentiated Casas Grandes Polychrome	–	–	–	–	1	0.5	–	–	–	–	–	–	–	–	1	0.2
Gila Butte Red-on-buff	–	–	–	–	–	–	–	–	–	–	–	–	1	2.0	1	0.2
Rio Grande Glaze Polychrome	–	–	1	0.6	–	–	–	–	–	–	–	–	–	–	1	0.2
Point of Pines Polychrome	–	–	–	–	3	1.6	–	–	–	–	–	–	–	–	3	0.7
Total Other Types	–	–	*1*	*0.6*	*13*	*6.7*	–	–	–	–	–	–	*1*	*2.0*	*15*	*3.3*
Undifferentiated White Ware	–	–	15	9.4	24	12.4	3	10.3	2	22.2	–	–	5	10.0	49	10.7
Undifferentiated Red Ware	–	–	–	–	–	–	1	3.4	–	–	–	–	–	–	1	0.2
Indeterminate	–	–	12	7.5	11	5.7	2	6.9	2	22.2	–	–	5	10.0	32	7.0
Total Undifferentiated/Indeterminate	–	–	*27*	*17.0*	*35*	*18.1*	*6*	*20.7*	*4*	*44.4*	–	–	*10*	*20.0*	*82*	*17.8*
Total	11	100.0	159	100.0	193	100.0	29	100.0	9	100.0	9	100.0	50	100.0	460	100.0

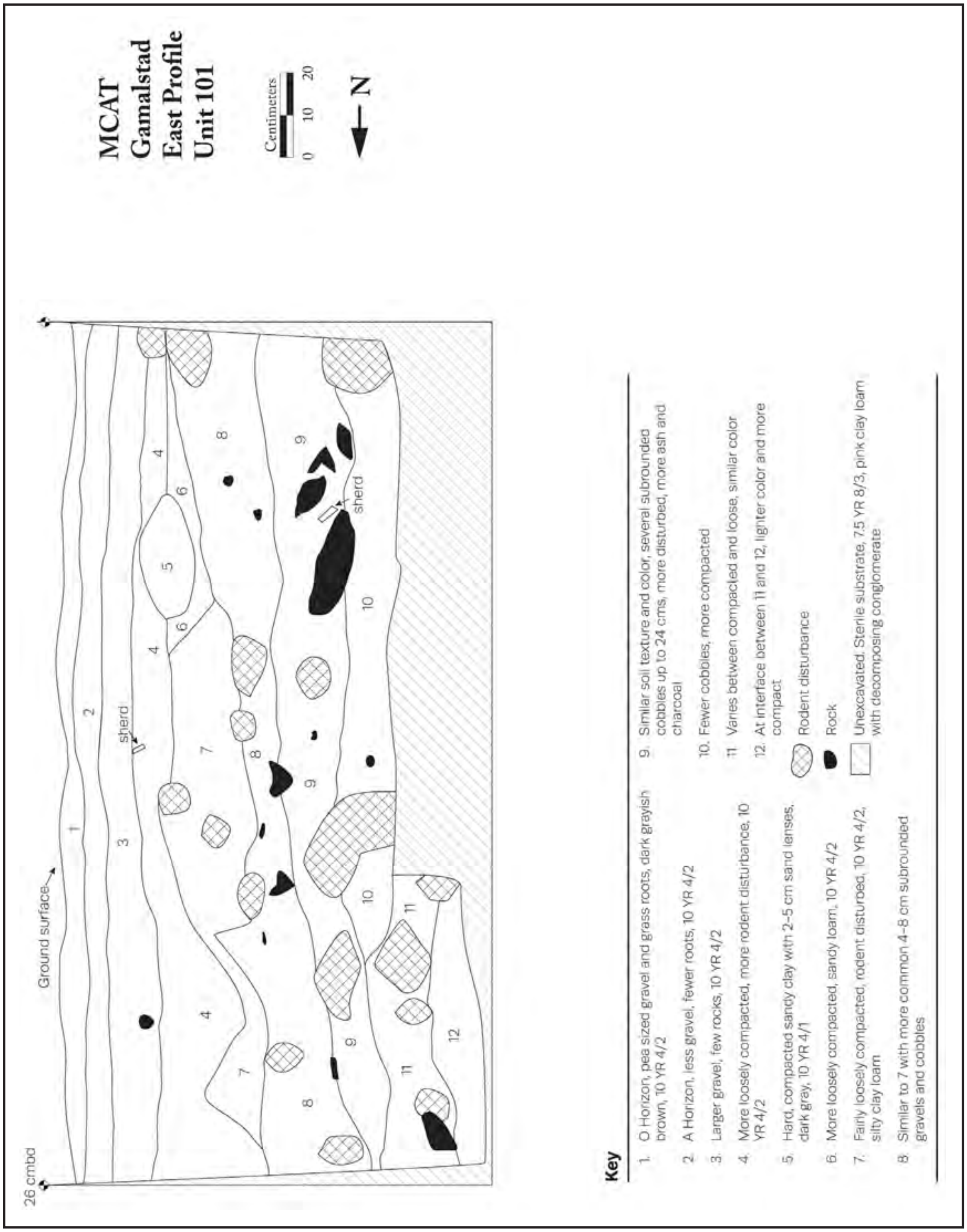

Figure 7.2. East profile of Mule Creek Archaeological Testing Project Unit 101, Feature 6 (Strata 11 and 12), with pit or possible pit structure, Gamalstad, LA 164472.

of a prepared floor, heavily disturbed by rodent burrows, were exposed at approximately 10 cm below the top of the surviving wall. Fill up to 10 cm below the floor was soft, ashy, and gray with a high charcoal density. Excavation was stopped at this level due to concerns about efficient use of time and the presence of subfloor burials in other architectural contexts in the greater Mimbres area.

Feature 3 was clearly interior architectural space, although the limited amount of exposed area makes it difficult to distinguish between a pit structure with masonry-lined walls and a later surface room (Figure

Figure 7.3. Photograph of Mule Creek Archaeological Testing Project Unit 102, showing wall foundation and floor remnant of structure Feature 3, Gamalstad, LA 164472.

7.3). In either case, the feature seems to have been built above an earlier, burned structure. No plausible masonry wall fall was recovered from within the unit. Two Mimbres Black-on-white Style II worked sherds were recovered from the floor fill. A large portion of a small corrugated pitcher, with a braided handle and an incised pattern producing a "braided" effect across two coils at the vessel's shoulder was recovered from the northern portion of the unit.

Small corrugated pitchers with similar handles but without incising have been recovered from burials at the Saige-McFarland site in the Upper Gila (Lekson 1990:Figure 3.9, Vessel 46), as well as from the Galaz site (Anyon and LeBlanc 1984:Plate 142E) and NAN Ranch in the Mimbres Valley. A similar vessel with an incised pattern was recovered from a burial at NAN Ranch (Shafer 2009:Figure A.23).

Based on the NAN material, Shafer (2009:186) has suggested that small, fully corrugated pitchers or mugs were produced for only a short time (between roughly AD 1000 and 1060) during the end of the Three Circle phase and the early Mimbres Classic phase. Whether the Mimbres Valley ceramic microseriation is applicable in the Upper Gila has yet to be confirmed. Decorated sherds recovered from the ashy subfloor level are consistent with a Late Pithouse period date for the earlier feature (see Table 7.2).

The apparent midden deposit, Feature 1, was similar across Units 101 and 102. The decorated ceramic assemblages are dominated by Mimbres Black-on-white styles, although Mimbres Black-on-white sherds unclassifiable to a specific style were more common than any individual style (see Table 7.2). The same Salado polychrome types present elsewhere at the site are also represented, although the Maverick Mountain series is not. More surprising are a few sherds of types not represented in any other assemblages yet recorded in Mule Creek. These include a few sherds of Ramos Polychrome, probably from a single jar, several sherds from a Point of Pines Polychrome bowl recovered from Unit 102, and a small sherd from a Rio Grande Glaze Ware polychrome vessel from Unit 101.

In addition, all the marine shell excavated from Gamalstad was found in these units (Appendix C, this volume), as was a substantial majority of the projectile points (see below) and the single partial figurine, a pinched quadruped. To some extent, the greater volume of fill and the higher general artifact density in these units may account for such diversity.

Unit 103 was a 1-m by 2-m excavation unit oriented roughly north-south; it contained sheet wash or shallow midden deposits. The unit was placed on the southwestern edge of a small rise in the southwestern portion of the site, in the hope that the topography was of cultural rather than natural origin. Although the rise is immediately adjacent to the heavily disturbed portion of the site, it is west of the fence line and is disturbed only by the two-track road running along the outside of the fence.

The unit was excavated in three 10-cm levels, with levels maintaining the slope of the ground surface, and a final truncated level that ended at the sterile substrate. Rodent disturbance was present in all levels, but increased substantially in the lower levels. Artifact density was low at the surface and in the first level. The presence of charcoal flecking and higher artifact density in the second level prompted the excavators to describe the fill as midden, designated Feature 4. Artifact density dropped somewhat in the third level, and the final level was mixed with sterile substrate and contained very little cultural material. Sediment below the root zone was dark, with a much lighter sterile. Dominant proportions of Salado polychromes, Cliff White-on-red, Maverick Mountain series ceramics, and obliterated corrugated—which distinguished this unit from the other 2009 units at Gamalstad—suggest the deposit dates primarily to the Cliff phase.

Units 104 and 105 were intended to explore an architectural feature on the central ridge in the northern portion of the site. This feature, designated Feature 2, consists of a long (25 m or more) northeast-southwest oriented rock alignment resembling the alignments of footing stones or *cimientos* visible at Cliff phase adobe room blocks at Locus C of the 3-Up site, LA 150373, and other Upper Gila sites. Unit 104 was a 1-m by 2-m unit placed immediately west of the alignment (the presumed exterior), with the long axis paralleling the alignment. Unit 105 was a 1-m by 1-m unit extending east toward the presumed interior of the alignment from the southern half of Unit 104.

A shallow upper stratum of low artifact density sheetwash was removedfrom both units. The *cimientos* were set in a narrow (circa 10-cm-wide) trench, surrounded by a comparatively loose dark brown fill; this inner trench was likely set in a wider, more gently sloping, basin-shaped trench, about 60 cm in width. Fill in this larger trench was somewhat lighter and more compact; the trench itself seems to have been excavated into the sterile substrate. Among the small number of artifacts recovered from Feature 2 were two Salado Polychrome sherds. A possible row of postholes outside the footer trench and parallel to the alignment was uncovered in Unit 104. These postholes were quite shallow (the deepest were measured at about 7 cm deep). They are, however, spaced fairly consistently relative to the alignment and to one another; the ground surface associated with use of the structure may have been higher.

Another apparent trench, Feature 5, roughly 10 cm wide and also excavated into the sterile substrate, was uncovered in the eastern half of Unit 105 (Figure 7.4). Feature 5 runs roughly parallel to Feature 2 but is oriented slightly more directly north-south. Fill within Feature 5 was lighter than that in Feature 2, although it did contain charcoal and a few artifacts, including a single Salado polychrome sherd. No prepared surface was found on either side of the alignment. Based on results of the excavation, the alignment does not seem likely to represent the remains of even a very heavily deflated adobe room block. Instead, the alignment may have served as a footer for a more ephemeral structure, albeit a very large one. If the depressions in Unit 104 are postholes, this might support

Figure 7.4. Photograph of Mule Creek Archaeological Testing Project Unit 105, showing upright cobble wall alignment Feature 2 and possible jacal wall groove to the east, Gamalstad, LA 164472.

the presence of some variety of jacal construction. The presence of Salado Polychrome suggests that, despite the apparent lack of adobe or masonry architecture, Feature 5 dates to the Cliff phase or later.

Unit 106 was a north-south oriented 1-m by 2-m unit located in the southwestern portion of the site. Unit 106 is adjacent to the northern edge of the knoll on which Unit 103 was located. The unit was excavated in seven 10-cm-deep levels following the slope of the ground surface, with the last level cutting into the sterile substrate. Unit fill was dark grayish-brown with moderate rodent disturbance above a lighter brown or orangish sterile. Charcoal or ash was present but not abundant, and artifact density was low, despite the depth of the deposit. Decorated ceramics in this unit are heavily mixed (see Table 7.2), with Salado polychromes, Mimbres Black-on-white style III, and Late Pithouse period types recovered from the lowest level. The unit is located inside the fence line of the heavily disturbed portion of the site and is close to one of the major bulldozer cuts still visible. This deposit may represent a push pile or backdirt from disturbance in this portion of the site.

CERAMICS

Ceramics from Gamalstad were analyzed using the methods outlined in Chapter 3 (this volume). Decorated counts and proportions are provided in Table 7.2, while counts of non-painted ware (both corrugated and non-corrugated) are shown, by unit, in Table 7.3.

In all, 2,852 unpainted sherds and 460 decorated sherds were recovered from seven excavated units. Most of the ceramics were from Units 101 and 102. Mogollon/Mimbres sherds are the most common overall, representing about 66 percent of all recovered decorated sherds; Salado polychrome types represent nearly 10 percent of decorated sherds. The remaining decorated ceramic assemblage is comprised of very small frequencies of other types, including Maverick Mountain Series, undifferentiated White-on-red, and various other types. Present in surface collections but not in excavated collections were three Red Mesa Black-on-white sherds and a single Playas Red Incised sherd.

Of the nearly 3,000 unpainted sherds recovered from Gamalstad, slightly less than 60 percent are non-corrugated brown ware. Corrugated brown ware is also common, at slightly less than 30 percent of all unpainted sherds. Present in much smaller proportions are corrugated and non-corrugated red-slipped brown ware, undifferentiated gray ware, and San Francisco Red. Interior smudging is present on 23 percent of all sherds for which this attribute could be coded (n = 2,173).

FLAKED STONE

Investigations at the Gamalstad site resulted in the recovery of more than 3,400 flaked stone artifacts. Of these, most are debitage. Debitage was sorted by material type (obsidian versus non-obsidian); counts and weights, by unit, are provided in Table 7.4. Obsidian debitage comprises approximately 47 percent of the debitage assemblage by frequency and some 20 percent by weight, with the Antelope Creek locality from Mule Creek the overwhelmingly dominant source (Appendix A, this volume). The ratio of obsidian to non-obsidian debitage is highest in Units 104, 105, and 106. Interestingly, although these units have Salado polychromes, they are not the units with the largest proportions of these types.

Detailed analysis was limited to the 34 bifacially retouched implements recovered from the site. These consist of 20 projectile points, 6 bifaces, 4 preforms, and 4 drills, all of which were made of obsidian. The bifaces were recovered from Feature 1, Feature 2, sheet trash contexts, and the site surface (Table 7.5). Attributes recorded for bifaces included raw material, cortical coverage, mass (g), and maximum linear dimension (mm).

Additional measurements taken on projectile points include the length, width, and thickness of the blade, neck width, haft length, and basal width.

The extensive Mule Creek obsidian source area is within walking distance of Gamalstad and is comprised of at least four chemically distinct groups (Shackley 2005:53). Results of EDXRF analysis show that most of the bifaces are made of Antelope Creek/Mule Creek obsidian (Tables A.1–A.2). Two are N. Sawmill Creek/Mule Creek obsidian. One projectile point was made of obsidian from the Gwynn Canyon source, located a linear distance of approximately 60 km northeast of the site.

Six of the bifaces appear to be in various stages of production. Based on form and retouch patterns, three were classified as early-stage bifaces and three were considered late-stage bifaces (see Table 7.5). These are generally subtriangular in shape, formed through pressure flaking, and they have rounded bases and thick midsections. One early-stage biface has shoulders and a small stem formed on the basal end, although the distal end is very thick and cortical. A large late-stage biface manufactured with both soft-hammer percussion and pressure flaking has serrations on both lateral edges, and it may have been considered a finished tool.

Four of the bifaces were worked into drills. Two drills have long bits and flared bases; one is thin and pressure flaked (Figure 7.5n), and the other is thicker and was made using soft-hammer percussion and pressure flaking (Figure 7.5o). The third drill is thick and triangular-shaped, with marginal pressure flaking (Figure 7.5p). A fourth drill has side notches, cortex on one aspect, and is missing the base (Figure 7.5m).

A variety of styles is represented among the 20 projectile points. Six of the points are Southwest Triangular types, which are common in post-AD 1150 occupations throughout Arizona and western New Mexico (Sliva 2006). These points are generally thin, unnotched, triangular points with straight to concave bases (Figure 7.5a–d). Two of the points are complete, and four are proximal fragments.

One basal-notched triangular point was recovered. This point has slightly convex blade margins, a deep basal notch, and very pronounced rounded ears (Figure 7.5e). The blade is only partially thinned, and one blade edge was not retouched. This point may be lacking side notches because it is unfinished, or it may be a variation of the unnotched triangular style. A similar point was recovered from the nearby Fornholt site, LA 164471; three were associated with fourteenth century occupations at Red Bow Cliff Dwelling in the Point of Pines region (Gifford 1980:Figure 39 l–m). Basal-notched points without side notches do not currently appear to have been widely distributed.

Six side-notched points were recovered. Two of these have notches placed low on their blades and flat to convex bases that are not as wide as the blade (Figure 7.5f–g). These points are somewhat similar to Pueblo Corner-/Side-notched points identified by Moore (2013:Figure 1j–l) from the Developmental period (AD 600–1200) in the northern Rio Grande region, although his examples are much wider. The points from Gamalstad were shaped through pressure flaking, although one has some step and hinge fractures that resulted in a relatively thick blade. A third, smaller point has a similarly shaped base and uneven notches and may be a variation of this particular template (Figure 7.5h). This point was made of obsidian from the Gwynn Canyon source, the only example of nonlocal material in the assemblage.

Another side-notched point has contracting C-shaped notches and a slightly concave base wider than the blade (Figure 7.5i). This style is consistent with side-notched points associated with the AD 1150–1350 interval in general, and Cliff or Salado phase occupations in the region (Nelson and LeBlanc 1986; Sliva 2006:59; see also Chapter 4). A long, narrow point with shallow notches placed low on the blade and a rounded base was not assigned a type (Figure 7.5j), and another point blade with a transverse break at the neck appears to have had shallow side notches as well.

Table 7.3. Unpainted ceramics, by unit, at Gamalstad, LA 164472.

	Unit 100			Unit 101			Unit 102			Unit 103			Unit 104			Unit 105			Unit 106			Total		
	S[a]	U[a]	I[a]	S	U	I	S	U	I	S	U	I	S	U	I	S	U	I	S	U	I	S	U	I
Non-corrugated Brown Ware	30	29	13	110	360	65	101	370	62	66	77	7	18	28	6	11	23	1	32	270	18	368	1,157	172
Non-corrugated Red Slipped	3	11	–	6	55	3	9	41	2	8	25	–	3	10	–	2	2	–	4	30	–	35	174	5
Smudged, burned, or eroded exterior	–	–	1	3	9	3	3	9	3	4	–	2	–	–	1	1	–	–	1	–	–	12	18	10
Undifferentiated Gray Ware	–	–	–	–	1	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	0	1	0
San Francisco Red	–	–	–	–	6	–	–	2	–	–	1	–	–	–	–	–	–	–	1	2	–	1	11	0
Unidentified non-corrugated	–	–	–	–	1	–	–	2	–	–	1	–	–	–	–	–	–	–	–	–	–	0	4	0
Non-corrugated Total	*33*	*40*	*14*	*119*	*432*	*71*	*113*	*424*	*67*	*78*	*104*	*9*	*21*	*38*	*7*	*14*	*25*	*1*	*38*	*302*	*18*	*416*	*1,365*	*187*
Corrugated Brown Ware	3	2	1	29	104	26	28	133	17	19	23	3	2	7	–	–	7	–	3	18	425	84	294	472
Corrugated Red Slipped	1	1	–	–	1	1	–	1	1	1	2	–	–	–	–	–	–	–	1	6	16	3	11	18
Smudged, burned, or eroded corrugated exterior	–	–	1	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	1	0	0	2
Corrugated Total	*4*	*3*	*2*	*29*	*105*	*27*	*28*	*134*	*18*	*20*	*25*	*3*	*2*	*7*	–	–	*7*	–	*4*	*24*	*442*	*87*	*305*	*492*
Total	37	43	16	148	537	98	141	558	85	98	129	12	23	45	7	14	32	1	42	326	460	503	1,670	679

[a]S = smudged; U = unsmudged; I = indeterminate interior.

Table 7.4. Proportions of obsidian versus non-obsidian debitage at Gamalstad, LA 164472.

Unit No.	Obsidian Count (*n*)	Obsidian Weight (g)	Non-obsidian Count (*n*)	Non-obsidian Weight (g)	Ratio Count[a] (*n*)	Ratio Weight[a] (g)
100	126	166.0	118	522.5	1.07	0.32
101	375	457.9	583	2,430.1	0.64	0.19
102	410	667.0	578	2,905.0	0.71	0.23
103	198	275.5	200	1,006.8	0.99	0.27
104	110	131.8	73	370.3	1.51	0.36
105	59	120.8	38	147.7	1.55	0.82
106	310	339.8	234	1,393.9	1.32	0.24
Total	1,588	2,158.8	1,824	8,776.3	0.87	0.25

[a]Ratio of obsidian to non-obsidian debitage.

Other projectile point fragments include a corner-notched point and a stemmed point. The corner-notched point is small, with an expanding blade and one downward-pointed tang (Figure 7.5k). The base is straight, and one ear is missing. Corner-notched points occur during the Late Pithouse to the Pueblo period at sites in western New Mexico (Dockall 1991; Martin et al. 1957:Figure 42m; Martin et al. 1952:Figure 45o–t; Nelson and LeBlanc 1986), but the rounded tang and base on this particular point does not conform to the typical Pueblo Corner-notched type. The stemmed point is small and thick in cross section (Figure 7.5l). A literature search of sites in the region shows few examples of Pueblo stemmed points. One is documented at the Saige-McFarland site, LA 5421, associated with the Three Circle to Mimbres phases (Lekson 1990:Figure 3.17c), and examples from unknown ceramic-period contexts were recovered from Bat Cave, LA 4935 (Dick 1965:Figure 20e, g). The remaining six projectile points from Gamalstad consist of nondiagnostic blade fragments.

Summary

A wide variety of projectile points are represented at Gamalstad. Southwest Triangular points are a common style, supporting a post-AD 1150 occupation. The side-notched and corner-notched points are more difficult to place temporally. The single point made from the distant Gwynn Canyon obsidian suggests the occupants of Gamalstad had social contact with groups to the northeast. While all the analyzed tools are obsidian, non-obsidian debitage predominates at the site.

FAUNAL ANALYSIS

The small faunal assemblage recovered from Gamalstad consists of 348 specimens (Table 7.6). Most were mammals (n = 295 specimens, or 85 percent), with a smaller number of birds (n = 6), reptiles (n = 3), and fish (n = 2). The assemblage is highly fragmented, with 91 percent of specimens less than 25 percent complete. This high degree of fragmentation is reflected in the 42 specimens (12 percent) that could not be identified to class or better. Only one bone tool was found in the assemblage—the tip of a very dull, broad-tipped awl-like tool made of large mammal bone (Feature 1, Unit 102, FN 2009.005).

The current analysis includes all the vertebrate fauna recovered from the 2009 excavations. All materials were recovered via dry screening through ¼-inch mesh. Coding during the analysis followed a modified version of the system used by Spielmann and Clark (2002) to analyze fauna from the Salinas area. The following attributes were recorded for each specimen (including bone artifacts): taxon (to the most specific level possible), element (or element category, such as long bone, if element-level identification was not possible), side, com-

Table 7.5. Analyzed flaked stone artifacts from Gamalstad, LA 164472.

Feature No.	FN/OSN	Context	Artifact Type	Projectile Point Type	Condition	Material	Length (mm)	Weight (g)	Figure No.
0	18/52	Sheet trash	Projectile point fragment	Triangular, basal-notched	Complete	Antelope Creek-Mule Creek obsidian	19.32	0.38	7.5e
0	44/60	Sheet trash	Projectile point fragment	Nondiagnostic fragment	Distal fragment	Antelope Creek-Mule Creek obsidian	12.51	0.19	–
0	44/58	Sheet trash	Preform	–	Very tip missing	Antelope Creek-Mule Creek obsidian	20.20	0.71	–
0	44/59	Sheet trash	Projectile point fragment	Southwest Triangular	Proximal fragment	Antelope Creek-Mule Creek obsidian	12.88	0.28	7.5d
0	167/81	Sheet trash	Projectile point fragment	Southwest Triangular	Proximal fragment	Antelope Creek-Mule Creek obsidian	12.65	0.50	–
0	167/82	Sheet trash	Preform	Antelope Creek-Mule Creek obsidian	Very tip missing	Antelope Creek-Mule Creek obsidian	21.28	0.99	–
0	323/83	Sheet trash	Complete early stage biface	–	Complete	Antelope Creek-Mule Creek obsidian	21.23	0.68	–
0	374/71	Sheet trash	Projectile point fragment	Nondiagnostic fragment	Distal fragment	Antelope Creek-Mule Creek obsidian	19.53	1.00	–
0	416/67	Surface?	Projectile point fragment	Nondiagnostic fragment	Distal fragment	Antelope Creek-Mule Creek obsidian	13.82	0.26	–
0	416/66	Surface?	Preform	–	Very tip missing	Antelope Creek-Mule Creek obsidian	19.47	0.54	–
0	416/64	Surface?	Drill	–	Complete	Antelope Creek-Mule Creek obsidian	32.12	1.34	7.5n
0	416/65	Surface?	Side-notched drill	–	Very base missing	Antelope Creek-Mule Creek obsidian	19.62	0.69	7.5m
0	416/63	Surface?	Complete late stage biface, serrated edges	–	Complete	Antelope Creek-Mule Creek obsidian	30.82	2.90	–
1	24/84	Feature fill	Projectile point fragment	Nondiagnostic fragment	Proximal fragment	Antelope Creek-Mule Creek obsidian	15.99	0.23	–
1	29/74	Feature fill	Preform	–	One ear missing	Antelope Creek-Mule Creek obsidian	29.26	1.28	–
1	29/79	Feature fill	Projectile point	Unspecified side-notched point	Complete	Gwynn Canyon obsidian	17.80	0.42	7.5h
1	29/75	Feature fill	Drill	–	Complete	Mule Creek-N. Sawmill Creek obsidian	20.26	0.90	7.5o
1	29/76	Feature fill	Projectile point	Southwest Triangular	Complete	Antelope Creek-Mule Creek obsidian	20.91	0.040	7.5b
1	29/78	Feature fill	Projectile point	Southwest Triangular	Complete	Antelope Creek-Mule Creek obsidian	19.85	0.43	7.5a
1	36/72	Feature fill	Complete early stage biface	–	Complete	Antelope Creek-Mule Creek obsidian	27.15	1.73	–
1	36/73	Feature fill	Projectile point	Unspecified side-notched point	Complete	Antelope Creek-Mule Creek obsidian	23.72	0.89	7.5f
1	38/51	Feature fill	Projectile point fragment	Small corner-notched point	Proximal fragment	Antelope Creek-Mule Creek obsidian	13.94	0.42	7.5k
1	55/62	Feature fill	Complete late stage biface	–	Complete	Antelope Creek-Mule Creek obsidian	15.93	0.36	–
1	55/61	Feature fill	Fragmentary late stage biface	–	Very base missing	Antelope Creek-Mule Creek obsidian	22.18	0.81	–
1	67/57	Feature fill	Projectile point fragment	Southwest Triangular	Proximal fragment	Mule Creek-N. Sawmill Creek obsidian	9.58	0.23	7.5c
1	67/56	Feature fill	Projectile point fragment	Southwest Triangular	Proximal fragment	Antelope Creek-Mule Creek obsidian	16.48	0.41	–
1	67/55	Feature fill	Projectile point	Shallow side-notched point	Complete	Antelope Creek-Mule Creek obsidian	25.05	0.66	7.5j
1	68/70	Feature fill	Complete early stage biface	–	Small stem at base	Antelope Creek-Mule Creek obsidian	24.14	1.12	–
1	68/69	Feature fill	Projectile point	Unspecified side-notched point	Complete	Antelope Creek-Mule Creek obsidian	17.20	0.25	7.5i

Table 7.5. Continued.

Feature No.	FN/OSN	Context	Artifact Type	Projectile Point Type	Condition	Material	Length (mm)	Weight (g)	Figure No.
1	68/68	Feature fill	Projectile point fragment	Unspecified side-notched point	Base missing	Antelope Creek-Mule Creek obsidian	15.46	0.24	–
1	81/85	Feature fill	Projectile point fragment	Unspecified small stemmed point	Proximal fragment	Antelope Creek-Mule Creek obsidian	11.11	0.39	7.5l
1	95/54	Feature fill	Projectile point fragment	Nondiagnostic fragment	Proximal fragment	Antelope Creek-Mule Creek obsidian	11.84	0.44	–
1	126/53	Feature fill	Drill	–	Very tip missing	Antelope Creek-Mule Creek obsidian	29.20	1.87	7.5p
2	162/80	Feature fill	Projectile point	Unspecified side-notched point	Complete	Antelope Creek-Mule Creek obsidian	22.87	0.51	7.5g

Note: See Chapter 4 (this volume) for a description of early and late biface stages.

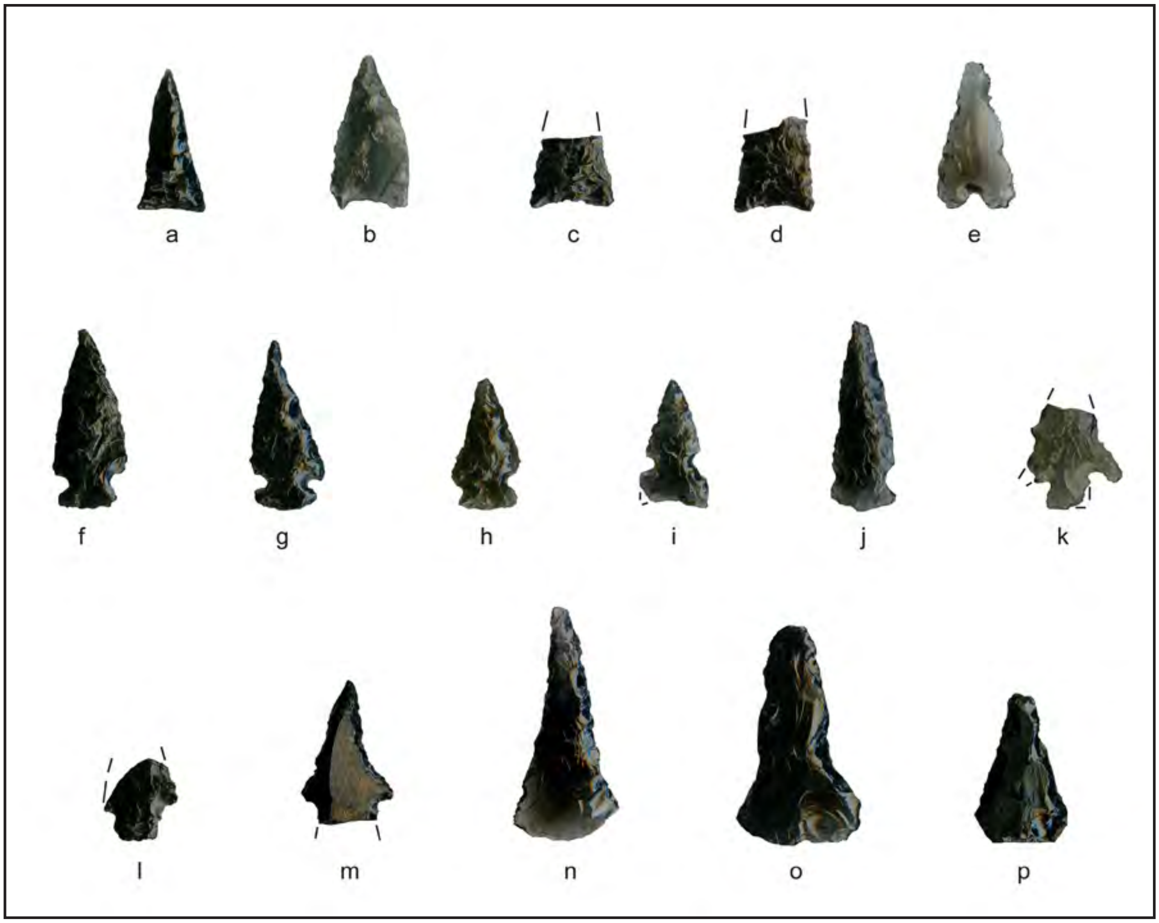

Figure 7.5. Select projectile points from Gamalstad, LA 164472: (a–d) Southwest Triangular points; (e) triangular basal-notched point; (f–j) unspecified side-notched points; (k) unspecified corner-notched point; (l) stemmed point; (m–p) drills.

pleteness (the approximate proportion of the element present), portion of the element present (such as the proximal end or the shaft), degree of fusion, a description of burning, if present, a description of any natural, animal, or human modifications to the specimen, weight of the specimen, and the maximum length of the specimen. Taxonomic identifications were made based on comparisons with the Stanley J. Olsen Laboratory of Zooarchaeology Comparative Vertebrate Collections at the Arizona State Museum (ASM), in addition to several reference manuals used to confirm diagnostic characteristics (Ford 1990; Gilbert 1973; Gilbert et al. 1996; Lawrence 1951; Olsen 1964, 1968, 1979; Schmid 1972).

Specimens identifiable as specific elements were identified to the lowest taxonomic level possible, usually genus or order. Many specimens could not be identified as a specific element, including numerous long bone shaft fragments and some fragments identified only as indeterminate elements. Such specimens were classified by size category based on their estimated circumference and the thickness of the cortical bone. Size categories were defined as: small bird (songbird-sized), medium bird (quail-sized), large bird (hawk-sized), very large bird (turkey-sized), unspecified bird (unknown size), very small mammal (small rodent-sized), small mammal (rodent-sized), small-medium mammal (rodent- to rabbit-sized), medium mammal (rabbit- to small carnivore-sized), medium-large mammal (carnivore- to artiodactyl-sized), large mammal (artiodactyl-sized), indeterminate small animal, and unidentified animal. Taxon identification was conservative, as it is more detrimental to misidentify a specimen to the wrong genus than to fail to identify a specimen.

Table 7.6. Inventory of animal bone from Gamalstad, LA 146672.

	Feature 1, Unit 101	Feature 1, Unit 102	Feature 1, Unit 6.01	*Feature 1 Total*	Feature 2, Unit 104	Feature 2, Unit 105	*Feature 2 Total*	Feature 3, Unit 102	Feature 4, Unit 103	Feature 5, Unit 105	Feature 6, Unit 101	Feature 0, Unit 100	Feature 0, Unit 103	Feature 0, Unit 104	Feature 0, Unit 105	Feature 0, Unit 106	Total
Class Mammalia																	
Order Artiodactyla	3	–	–	*3*	–	–	–	–	–	3	–	–	1	–	–	–	7
Odocoileus sp.	1	1	–	*2*	–	–	–	–	–	1	–	–	–	–	–	–	3
Antilocapra americana	1	–	–	*1*	–	–	–	–	–		–	–	–	–	–	–	1
Large mammal	43	33	1	*77*	–	1	*1*	9	3	49	4	10	5	3	3	16	180
Large-medium mammal	–	–	–	–	2	–	*2*	–	–	–	–	–	–	–	–	–	2
Order Lagomorpha	–	–	–	–	–	–	–	–	–	–	–	1	–	–	–	–	1
Lepus sp.	1	1	–	*2*	–	–	–	–	–	–	–	1	–	–	–	–	3
Sylvilagus sp.	2	2	–	*4*	–	–	–	1	1	–	2	–	1	–	–	3	12
Order Rodentia	3	4	–	*7*	–	–	–	2	–	1	3	1	–	–	–	1	15
Thomomys sp.	–	1	–	*1*	–	–	–	–	–	–	–	–	–	–	–	–	1
Small mammal	23	8	–	*31*	–	–	–	9	–	9	1	–	1	2	–	17	70
Class Aves																	
Very large bird	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	1	1
Large bird	–	–	–	–	–	–	–	–	–	–	–	–	1	–	–	–	1
Medium bird	2	–	–	*2*	–	–	–	–	–	–	–	–	–	–	–	1	3
Small bird	–	–	–	–	–	–	–	–	–	–	–	–	1	–	–	–	1
Class Reptilia	1	–	–	*1*	–	–	–	1	–	–	–	–	–	–	–	–	2
Order Testudines	–	1	–	*1*	–	–	–	–	–	–	–	–	–	–	–	–	1
Superclass Osteichthyes	–	–	–	–	–	–	–	1	–	1	–	–	–	–	–	–	2
Indeterminate small animal	1	–	–	*1*	–	1	*1*	–	–	–	–	–	–	–	–	1	3
Unidentified animal	4	3	–	*7*	–	–	–	4	1	6	5	–	1	3	8	4	39
Total	85	54	1	*140*	2	2	*4*	27	5	70	15	13	11	8	11	44	348

Bones were quantified by number of identified specimens (NISP). Fragments of recently broken elements were refitted and counted as a single specimen whenever possible. Minimum number of individuals (MNI) was not calculated in this analysis; this measure depends heavily on the units selected for assemblage aggregation (Grayson 1984), and MNI carries a high risk of inappropriately combining materials from different temporal or depositional contexts in villages occupied by multiple households over an extended period of time.

Taxa identified in the assemblage included five mammal genera, as well as unidentified birds, reptiles, and fish (see Table 7.6). Pronghorn (*n* = 1) and deer (*n* = 3) elements were identified to genus based on comparison with the comparative collection and criteria defined in Lawrence (1951) and Ford (1990). An additional seven specimens were identifiable as artiodactyls of unknown genus, and 180 specimens of artiodactyl-sized mammal bone in the assemblage could not be identified to order.

Both jackrabbits (*Lepus* sp.; *n* = 3) and cottontails (*Sylvilagus* sp.; *n* = 12) are represented, and both genera are present in the area today. The jackrabbits are likely to be *Lepus californicus* based on the modern distribution of that species, although they possibly represent *L. alleni* or *L. callotis* if the range of those species was different in the past. Both are present today in other parts of southwest New Mexico (Hoffmeister 1986). Similarly, the cottontails are likely to be either *Sylvilagus floridanus* or *S. audobonii*, or possibly *S. nuttalli* if the past distribution of that species differed slightly from the modern distribution (Hoffmeister 1986). The assemblage also includes one lagomorph specimen not identifiable to genus, and an additional 70 unidentified specimens in the cottontail- to rodent-sized range. One pocket gopher (*Thomomys* sp.) specimen was identified, as were 15 rodent specimens not identifiable to genus.

Nonmammalian specimens were identifiable only to class or order. These included six birds in four size classes, one turtle or tortoise scute (most likely turtle), two additional unidentified reptile specimens, and two fish vertebrae.

The small faunal assemblage from Gamalstad did not contain any unusual taxa, and it appears typical for faunal assemblages from this area and time period.

OTHER ARTIFACTS AND ECOFACTS

Testing at Gamalstad produced a large number of shell items (see Appendix C). Macrobotanical remains from Gamalstad were analyzed and are discussed in Chapter 6 (this volume).

In all, 26 ground stone items were recovered from testing at Gamalstad (Table B.1). Ground stone tools include 4 manos, 2 abraders, 2 lapstones, 1 chopper, 1 handstone, 1 metate, and 1 netherstone. Also present are 6 shaped architectural stones, 1 single shaped indeterminate item, 2 stone items that may have been potlids, and 5 unidentified items (see Appendix B). Andesite is the most common material represented in the ground stone assemblage, followed by dacite, vesicular basalt, rhyolite, quartzite, undifferentiated volcanic, and volcanic breccia (Table B.2).

SUMMARY

Seven test units were excavated at Gamalstad. All these units were shallow, with depths ranging from 22 cm to 1 m. These excavations exposed several features at the site, including likely trash midden deposits (Features 1 and 4), possible wall alignments (Features 2, 3, and 5), and a possible pit structure (Feature 6).

Both surface collections and excavation units at Gamalstad indicate this was a Late Pithouse to Classic Mimbres settlement with a small Salado reoccupation. It was difficult to place units in likely Cliff phase midden areas given the extent of previous disturbance at the site. The test units largely sampled deposits that were stratigraphically mixed with Mimbres deposits, despite the presence of Salado polychromes and other Late Pueblo period ceramic types on the surface of the site. Available evidence (primarily decorated ceramic types) suggests Gamalstad was occupied over the same time range as the 3-Up site, and despite heavy disturbance, its assemblage is richer and more diverse.

CHAPTER 8

MULE CREEK ARCHAEOLOGICAL TESTING PROJECT SURVEY

Robert Jones, Deborah L. Huntley, and Katherine Dungan

The Mule Creek valley of New Mexico is a well-watered, upland prairie environment with a small but rich riparian corridor along the Mule Creek drainage. Beginning in 2008, researchers from the Center for Desert Archaeology (now Archaeology Southwest) spent five field seasons conducting excavation and survey in the valley, including investigations at the 3-Up site, LA 150373, and Gamalstad, LA 164472, included in this report, as well as at the Fornholt site, LA 164471, to be reported elsewhere. During fieldwork, eight sites in the vicinity of the 3-Up site were revisited and documented, as were two sites on another property owned by Morgan Gust. These sites were recorded in 2005 by Karen Schollmeyer and Steve Swanson of Arizona State University (ASU) during an informal survey conducted on horseback. ASU researchers observed 22 sites, including 3-Up, during that survey. As part of the Mule Creek Archaeological Testing Project (MCAT), six new sites near 3-Up were recorded during an informal pedestrian survey in 2010.

LA numbers were obtained for all 27 sites, including those originally recorded by ASU and those recorded as part of the MCAT survey. Although basic site attributes, including features and artifacts present, were recorded, detailed sketch maps were not produced. Because land ownership has changed since the site visits and the completion of this report, we have been unable to revisit the sites to make sketch maps. The 27 sites are described here. They are primarily small room blocks and artifact scatters on the terraces above Mule Creek (Table 8.1).

Many of these sites were likely first recorded by Mimbres Foundation researchers in the 1970s, but were never assigned LA numbers. Where possible, survey sites have been identified by Mimbres Foundation site number (see Table 8.1) in addition to other field and LA numbers. A more thorough review of Mimbres Foundation records is needed to identify additional sites originally recorded by the Mimbres Foundation.

MC 1, LA 178280

MC 1, LA 178280, is in the Harden Cienega area northwest of Mule Creek; it was recorded by ASU. The site consists of three masonry room block areas, Features 1–3, surrounded by a large artifact scatter. Feature 1 consists of a block of at least three clearly visible cobble masonry rooms, with additional rock fall suggesting at least 5–6 total rooms. One room at the northwest corner of this small room block has been potted. Some ground disturbance was noted in this room during an informal visit in 2000, and additional disturbance occurred between 2002 and 2005. Excavation has exposed 1–2 courses of cobble masonry walls and deposits approximately 40 cm in depth. A particularly dense artifact scatter extends 20 m south and 10 m east and west of the Feature 1 room block. Ceramics observed near Feature 1 include the following diagnostic types (in descending abundance): Mimbres Transitional/Classic Black-on-white (Style II/III), Mimbres Classic Black-on-white (Style III), San Francisco Red, Mimbres Boldface/Transitional Black-on-white (Style I/II), and Reserve Red Smudged.

Feature 2 consists of at least one small but clearly visible cobble masonry room surrounded by a larger area of powdery, disturbed soil that possibly includes 3–4 rooms. Loose soil washing down from the hillslope above and south of the site has obscured much of this area, covering up possible additional walls.

Table 8.1. Summary information for Mule Creek area small sites.

LA Site No.	Field No.[a]	Site Type	Age	Collections?
178280	MC 1	Multiple masonry room blocks	Classic Mimbres	No
178281	MC 2	Masonry room block	Classic Mimbres	No
178282	MC 3	Pithouse and masonry rooms	Pithouse and Classic Mimbres periods	No
178283	MC 4	Masonry room block	Classic Mimbres, possibly Black Mountain phase	Yes
178284	MC 5	Adobe room block	Cliff phase	No
178285	MC 6	Pithouse and adobe room block	Cliff phase?	No
178286	MC 7, MAC 65?	Masonry room block	Classic Mimbres?	No
178287	MC 8, MAC 62 or 63	Pithouse and masonry room block	Pithouse and Mimbres Classic periods	Yes
178288	MC 9, MAC 60	Masonry room block	Classic Mimbres?	Yes
178289	MC 10, MAC 78	Pithouses, masonry room block and masonry rooms	Late Pithouse and Mimbres Classic periods	Yes?
178290	MC 11	Pithouses and masonry adobe room	Late Pithouse/Early Classic Mimbres	No
178291	MC 12, MAC 75?	Masonry room block	Classic Mimbres?	No
178292	MC 13, MAC 76	Masonry room	Classic Mimbres?	No
178293	MC 14, MAC 74	Pithouse	Unknown	No
178294	MC 15	Pithouse	Unknown	No
178295	MC 16, MAC 73	Masonry room block	Cliff phase?	No
178296	MC 18, MAC 69?	Pithouses	Unknown	No
178297	MC 19, MAC 68	Masonry room block	Unknown	No
178298	MC 20, MAC 67	Masonry room block	Unknown	No
178299	MC 21	Masonry room	Classic Mimbres?	No
178300	MC 22	Masonry room block	Unknown	No
178301	MCAT 2010-5	Lithic scatter, possible features	Unknown, possibly Apache	No
178302	MCAT 2010-6	Lithic scatter	Unknown	No
178303	MCAT 2010-7	Possible pithouse	Pithouse period?	No
178304	MCAT 2010-8	Masonry room block	Unknown	No
178305	MCAT 2010-9	Lithic scatter	Unknown	No
178306	MCAT 2010-10	Lithic scatter	Unknown	No

[a]MC numbers are sites originally recorded by Arizona State University in 2005; MCAT sites were newly recorded in 2010; MAC numbers are Mimbres Foundation numbers. MC 17 (aka 3-Up, LA 150373) is not included in the table.

Feature 3 consists of at least one clearly visible cobble masonry room surrounded by juniper trees. Rubble around the room suggests a total of 2-3 rooms in this room block, which is mostly obscured by junipers and juniper roots. Ceramics observed around this room block include the following diagnostic types (in descending abundance): Mimbres Transitional/Classic Black-on-white (Style II/III), Mimbres Boldface/Transitional Black-on-white (Style I/II), San Francisco Red; Mimbres Boldface Black-on-white (Style I).

MC 2, LA 178281

MC 2, LA 178281 is in the Harden Cienega area northwest of Mule Creek; it was recorded by ASU. The site consists of a 12- to 16-room cobble masonry room block and associated artifact scatter. Disturbances from a fence line 15 m north of the room block, a road 5–15 m south of the room block, heavy machinery used during road maintenance and juniper clearing, and a small rill 2 m east of the room block have obscured portions of the site. An area disturbed by heavy machinery at the north end of the room block has obscured some wall alignments. The artifact scatter associated with the room block extends to the Gila National Forest fence line; the area north of the fence was not examined. The artifact scatter also extends south and west to the road and east to the edge of the rill. It is particularly dense in the flat area containing few rocks between the room block and this rill.

MC 3, LA 178282

MC 3, LA 178282 is a small, multicomponent site on a ridge just north of the Harkey ranch house. Originally recorded by ASU, the site was revisited as part of the MCAT survey. Architectural features include at least two clear pit depressions and several disturbed rock alignments, although these were difficult to trace due to the rocky substrate. The ASU researchers identified these alignments as two freestanding cobble masonry rooms. The site boundaries recorded during the current survey reflect the artifact scatter rather than the visible architecture. Surface artifacts include unidentified Mimbres Black-on-white (including possible Style III), plain brown ware, clapboard corrugated (polished and unpolished), and polished indented corrugated. A telephone pole a few meters west of the site, an old road cut, and a fence line have caused some disturbance to the site.

MC 4, LA 178283

MC 4, LA 178283 is a small masonry room block and associated artifact scatter on a low rise south of the road leading to LA 150373. The site was originally recorded by ASU researchers, and it was revisited as part of the MCAT survey. Some intact rock alignments are visible in addition to substantial wall fall and rubble. Two to four rooms are estimated based on the extent of rock alignments. The artifact scatter is primarily east of the room block, and it consists of Mimbres Black-on-white style III and indeterminate style II or III, smudged brown ware, and corrugated types including clapboard, indented, and smeared corrugated. An extensive lithic scatter contains primarily obsidian, as well as an array of diverse material types typical to sites in the area. No ground stone was observed, although a single quartz crystal was noted. A small ceramic collection was made in 2010, and the scatter and rubble boundaries were mapped.

MC 5, LA 178284

MC 5, LA 178284 was visited in 2005 by ASU researchers, who made a small surface collection. The site was revisited in 2008 and mapped with a handheld GPS unit. The site is located on a first terrace southeast of Mule Creek and just east of a two-track ranch road. It consists of a 100-m^2 area of adobe melt that probably represents a small Cliff phase/Salado room block. The room block is situated within a larger artifact scatter with additional traces of adobe melt. Gila Polychrome is the dominant identifiable decorated ceramic type on the site.

MC 6, LA 178285

MC 6, LA 178285 was recorded by ASU researchers; it was not revisited as part of the current survey. The site is located on a low hilltop southeast of Mule Spring and consists of a small room block containing at least three rooms, an associated artifact scatter, and a possible pithouse depression. A bedrock mortar is located 30 m northwest of the masonry room block. Visible wall alignments consist of large (50 cm) rectangular stones resembling nearby bedrock outcrops. Very little wall fall is visible, suggesting the stones may have formed the bases of jacal room walls or *cimientos* for adobe walls. A 3-m by 4-m area of soft, dark soil located 3 m north of the room block may be a pithouse, although surface examinations were inconclusive. The ASU researchers attribute this site to the Cliff phase, presumably based on the possible *cimiento* alignments, but no diagnostic ceramic types were noted.

MC 7, LA 178286

MC 7, LA 178286 consists of a cobble masonry room block containing some six rooms. It was recorded by ASU researchers and was not revisited as part of the MCAT survey. An associated artifact scatter is reportedly present; sherds are almost entirely plain ware and corrugated ware with one red ware sherd noted. The site was only briefly visited, and no sketch map produced.

MC 8, LA 178287

MC 8, LA 178287 is located on a low rise above the Mule Creek floodplain, almost due east of MC 9. Several alignments of large cobbles outline a small room block (approximately four rooms). Visible wall alignments consist of large, 50-cm-rectangular stones resembling local bedrock, and very little wall fall is visible. Two pithouse depressions were recorded during the 2005 survey. Both depressions contain high concentrations of artifacts and dark, organic soil. A small, 1-m by 1-m square cobble feature of unknown function is located 12 m north of the western end of the room block, and it contains a very high concentration of sherds.

The artifact scatter associated with the features at MC 8, LA 178287 is dense and diverse compared with other small sites in the area. A ceramic collection made in 2008 included several sherds of smudged and unsmudged brown ware, several clapboard corrugated sherds, a few red slipped brown ware sherds, and a single sherd of Mimbres Black-on-white (Style III). Collected flaked stone included three obsidian projectile points (two of which are much larger than the triangular or side-notched points associated with Late Pueblo period occupations) and a large biface fragment, probably made of rhyolite. The ASU researchers also reported observing a mano fragment.

MC 9, LA 178288

MC 9, LA 178288 is situated on top of a steep ridgetoe that extends north toward Mule Creek. It overlooks the creek where it leaves the canyon and begins to form a floodplain. The site consists of several large cobble alignments, probably a contiguous room block, surrounded by a dense artifact scatter. Two large junipers have disturbed the room block itself, which probably contains at least six rooms. Walls are composed of rectangular cobbles resembling local bedrock, and very little wall fall is visible. One small obsidian projectile point and an obsidian biface were collected in 2008, as was a ceramic grab sample (plain, corrugated, and red-slipped brown ware sherds).

MC 10, LA 178289

MC 10, LA 178289 consists of a large cobble masonry room block, at least five pithouse depressions, and possible freestanding masonry structures located on top of a bluff above the canyon formed by a drainage emptying into Mule Creek from the north. Originally recorded by ASU, the site was revisited in 2010 during the MCAT survey.

The western portion of the site contains the largest number of architectural features. The large masonry room block in this area includes at least eight rooms that are clearly visible based on surface alignments, although the overall dimensions (based on fragments of visible walls) suggest it may include 30–40 rooms. Many of the wall alignments are difficult to see; some are covered with eroded soil from the site or by vegetation, and others have been disturbed by pothunting. Four looter's pits are visible in this room block, including a large pit and associated backdirt in the northern corner. Looting appears to have been recent, occurring within the last two years prior to ASU's 2005 recording. A large, 10-m-diameter, clearly visible pithouse depression is located 45 m north of the north end of the room block. It contains a high concentration of ceramics and dark, organic soil. A second, similar pithouse depression, 5 m in diameter, is located 10 m north of the first depression. A third area, 25 m by 30 m, containing at least three overlapping pithouse depressions is located 15 m south of the large masonry room block. The eastern portion of the site consists of two more rooms and additional possible pithouse depressions. Several bedrock mortars were also noted in this area.

An artifact scatter covers the entire site area. A particularly dense area surrounds the large (western) masonry room block. Ceramic types noted in 2010 included plain brown ware, clapboard and polished indented corrugated, San Francisco Red, and Mimbres Black-on-white (Styles I and III). ASU researchers collected a small ceramic sample from the site. Except the 3-Up site, MC 10, LA 178289 is the most substantial Mimbres settlement yet recorded within the survey area.

MC 11, LA 178290

MC 11, LA 178290 was recorded by ASU researchers and was not revisited as part of the MCAT survey. It consists of a single cobble masonry or adobe room, at least three pithouses, and an associated artifact scatter. The room is 4 m by 2 m, with very little visible wall fall. Pithouse A is a clearly visible depression 7 m in diameter and is located 17 m north of the masonry room. The depression contains a relatively high concentration of ceramics and dark, organic soil consistent with a pithouse. Pithouses B and C, located approximately 12 m west and northwest of Pithouse A, are each about 6 m in diameter and appear similar to Pithouse A. An artifact scatter extends from the edge of the terrace west to the hillslope above the terrace; an especially dense area of artifact scatter covers the terrace edge and lower areas near the north end of the site. The ASU researchers identified this site as Late Pithouse/early Classic Mimbres, although if the room is adobe, it probably dates later.

MC 12, LA 178291

MC 12, LA 178291 is a cobble masonry room block and associated artifact scatter located on the first terrace above and north of Mule Creek. A brief examination by ASU researchers suggested the site contains some six rooms and is probably Classic Mimbres. The site was briefly visited, and no sketch mapping or in-field artifact analysis was done. This site was not revisited during the MCAT survey.

MC 13, LA 178292

MC 13, LA 178292 consists of a single cobble masonry room (possibly a Classic Mimbres fieldhouse) with a sparse associated artifact scatter of unknown density and dimensions. The site was briefly examined by ASU researchers, but no sketch map was made, nor was an in-field artifact analysis conducted. MC 13, LA 178292 was not revisited during the current survey.

MC 14, LA 178293

MC 14, LA 178293 consists of a single visible pithouse depression, although it may contain a few additional buried pithouses. Artifacts concentrated in the depression and dark, organic soil indicates archaeological deposits are present. The site was briefly visited by ASU researchers, but no sketch mapping or in-field artifact analysis was done. This site was not revisited during the MCAT survey.

MC 15, LA 178294

MC 15, LA 178294 consists of two visible pithouse depressions and a sparse associated artifact scatter. Both depressions contain high concentrations of ceramics and dark organic soil. ASU researchers briefly visited the site; no sketch map was made, nor was in-field artifact analysis conducted. MC 15, LA 178294 was not revisited during the MCAT survey.

MC 16, LA 178295

MC 16, LA 178295 is a small site situated on the first terrace above Mule Creek. Originally recorded by ASU researchers and revisited during the MCAT survey, the site consists of a single square room, roughly 3 m by 3 m, with two clearly visible rooms and some wall fall. The associated light artifact scatter is comprised predominately of large flakes of worked chert and obsidian, with a single Maverick Mountain series sherd found just outside the room. Not much time was spent at the site by the ASU researchers nor during the current work. A sketch map was not made and no in-field artifact analysis was conducted.

MC 18, LA 178296

MC 18, LA 178296 contains a cluster of at least 10 pithouses spread along the first terrace north of Mule Creek and east of the Larremore Ranch. Some pithouses are clear, visible depressions containing high concentrations of artifacts and dark organic soil; others are more subtle depressions with fewer artifacts. The site was briefly visited by ASU researchers, and no sketch map was made, nor was in-field artifact analysis conducted. The site was not revisited during the current survey.

MC 19, LA 178297

MC 19, LA 178297 was originally recorded by ASU researchers as a four-room cobble masonry room block with few artifacts. The site is directly north of Mule Creek on a low ridge, and it includes several cobble alignments and a small artifact scatter. Only two rooms were obvious in 2008. Artifacts were primarily unpolished brown ware sherds and chert flakes. Some slipped corrugated sherds and a few red-slipped sherds were observed. Not much time was spent at this site; therefore, no sketch map was prepared nor was a detailed in-field artifact analysis conducted.

MC 20, LA 178298

MC 20, LA 178298 was briefly visited by ASU researchers. The site consists of a masonry room block containing roughly 12 rooms. The site reportedly extends onto an adjacent property, with additional room blocks located in that area. The ASU researchers did not prepare a sketch map or conduct in-field artifact analysis. MC 20, LA 178298 was not revisited during the MCAT survey.

MC 21, LA 178299

MC 21, LA 178299 is a probable Classic Mimbres fieldhouse recorded by ASU researchers; very few artifacts were present. The ASU researchers did not prepare a sketch map or conduct in-field artifact analysis. The site was not revisited during the current survey.

MC 22, LA 178300

MC 22, LA 178300 is adjacent to MC 4, LA 178283, and it consists of a 1- to 2-room masonry room block and associated artifact scatter. The sparse artifact scatter was limited to plain brown ware and flaked stone. ASU researchers originally recorded the site; wall alignments and artifact scatter boundaries were mapped in 2010 as part of the MCAT survey.

MCAT 2010-5, LA 178301

MCAT 2010-5, LA 178301 is located on a high ridge overlooking Mule Creek. The site consists of a lithic scatter with some small rock alignments and possible wickiup rings. The lithic scatter is fairly diverse, with bifacially worked obsidian, fine-grained basalt, and metavolcanic debitage. No ceramics were noted, although a rocky substrate and some ground cover made surface visibility low.

MCAT 2010-6, LA 178302

MCAT 2010-6, LA 178302 is a dense lithic scatter on a ridge southeast of the 3-Up site. The lithic scatter contains large flakes, primarily of obsidian and rhyolite. The boundaries of the lithic scatter are fairly diffuse, but the area of greatest density was mapped.

MCAT 2010-7, LA 178303

MCAT 2010-7, LA 178303 is located on the crest of a low hill west of 3-Up. The site includes a possible pithouse depression and a scatter of ceramics and flaked stone. Ceramics are limited to plain brown ware and at least one red-slipped sherd. The flaked stone assemblage is dominated by obsidian, although that assemblage displays the diversity typical of the area and includes metavolcanics and fine-grained basalt.

MCAT 2010-8, LA 178304

MCAT 2010-8, LA 178304 is 3.5-m by 2.0-m room block defined by a rectangle of local conglomerate slabs set into the existing ground surface. A relatively dense lithic scatter dominated by obsidian surrounds the room block, and a single red-slipped sherd was found nearby. No other artifacts or features were noted. The outline of the room block was mapped.

MCAT 2010-9, LA 178305

MCAT 2010-9, LA 178305 is a dense lithic scatter near MCAT 2010-8, LA178304, and it may be a work area associated with that room block. The scatter consists primarily of obsidian, although a single mano was also observed.

MCAT 2010-10, LA 178306

MCAT 2010-10, LA 178306 is a large lithic scatter spread across a yucca-covered ridge on the terrace above Mule Creek. Artifacts are primarily gray metavolcanic flakes stone, in addition to obsidian and chalcedony. Artifact density declines at the edge of the hill, but continues at a low density outside the site boundary (and probably across much of the terrace).

CHAPTER 9

3-UP SITE INTERPRETATIONS AND CONCLUSIONS

Deborah L. Huntley

Archaeological research in Mule Creek is still in the preliminary stage, although results from recent work provide baseline data on site chronology and social relations during the thirteenth and fourteenth centuries AD in the study area. These data can be revised and refined by future work. As expected, fieldwork in this inadequately documented area uncovered more questions than answers. Interpretations based on the 2008 and 2009 fieldwork in Mule Creek are presented in this volume. Given the poor condition of the Gamalstad site, LA 164472, and the limited efforts there, the few synthetic conclusions about the site are presented in Chapter 7 (this volume). The focus of this chapter is on the 3-Up site, LA 150373.

SITE CHRONOLOGY

Ceramic data suggest the 3-Up site was occupied, perhaps continuously, throughout the Late Pithouse period (Three Circle phase), the Classic Mimbres period, and the later Kayenta and Salado (Cliff phase) periods. Evidence for occupation during the Tularosa/Black Mountain phase is less secure, particularly given the broad date ranges for the ceramic types considered diagnostic of this time period and their comparative scarcity at the site. However, the Arizona State University (ASU) ceramics collection from both Locus A and Locus B includes Reserve or Tularosa black-on-white, and both the ASU and the Mule Creek Archaeological Testing Project (MCAT) collections contain Tularosa Fillet Rim and St. John's Polychrome. This supports the presence of a thirteenth century AD occupation at the site.

Locus A, located on a small hill, is the most prominent and deeply stratified deposit at the site, with temporally diverse decorated ceramic types representing a variety of regional traditions. Occupation of this locus spans the period from AD 900 to 1400, although breaks in occupation would not necessarily be visible at the current level of archaeological resolution.

A pre-Cliff phase Kayenta enclave in Locus B is indicated by a high proportion of Maverick Mountain Series ceramics. Further support for the presence of such an enclave is provided by differences in projectile point styles (Chapter 4, this volume) and the presence of large birds, especially raptors such as hawks and at least one turkey (Chapter 5, this volume). Raptor burials and caches (especially wings) are associated with known Kayenta enclaves in the San Pedro Valley (Clark, Hill, Lyons et al. 2012:375-377) and are generally associated with Ancestral Pueblo sites (Hill 2000:365–368), where many have been recovered from ceremonial structures (McKusick 2001:96). This locus was likely occupied during the production period of Gila Polychrome, but it may lack the concentration of later Salado polychromes found elsewhere at the site.

Locus C is an outlying Cliff phase Salado occupation dominated by late Roosevelt Red Ware types, and it was occupied somewhat later than Locus B. Notably, the only perforated plate—one of the most reliable markers for the presence of Kayenta groups (Lyons and Lindsay 2006)—was recovered from the floor of an inadvertently sampled room in Locus C.

While Locus A may have been occupied throughout the sequence, the strong ceramic differences between Locus B (Maverick Mountain series and Gila Polychrome) and Locus C (Cliff Polychrome and other late types) indicate the two room blocks may have been occupied sequentially, although there is substantial overlap in ceramic date ranges.

ENVIRONMENTAL SETTING

The 3-Up site is located in an attractive environmental setting for exploitation of both wild and cultivated resources. Abundant game is suggested both by the excavated faunal remains and the extant wildlife in the area. Significant numbers of elk and deer, as well as smaller animals, were frequently seen at the site during the current project. The site is located adjacent to a substantial floodplain, much of which could be easily cultivated even today with irrigation from the currently flowing stream and springs in the area. In general, the Mule Creek area appears to be relatively lightly degraded by recent Euro-american land use. The stream channels are only modestly incised, and water tables are currently only 2.0–2.5 m below ground surface. Local accounts indicate Mule Creek formerly had a more substantial flow, although it still appears to be perennial in several locations and provides sub-irrigated floodplain in some areas today.

The 3-Up site is in a particularly good location within the valley based on the presence of two geomorphological factors that affect hydrological flow adjacent to the site. One of the largest tributaries in the valley joins Mule Creek at the 3-Up location, and there is a bedrock uplift beneath the site. Both of these conditions constitute reach boundaries as defined by Nials et al. (2011) in that they contribute to elevated ground water levels that enhance surface flow of streams and springs and improve conditions for irrigation. Stream reach conditions also make this an area that would likely have been one of the best and most reliably watered locations in the valley during periods of drought and channel incision.

MIGRATION

Based on previous research and the current investigations at the 3-Up site, at least two pulses of migration are postulated. The first is a Kayenta migration in the late thirteenth or early fourteenth century AD evidenced by the Maverick Mountain Series ceramics found throughout the tested loci but concentrated at Locus B. The greater Upper Gila region has been described as an empty frontier at this time. However, data presented here suggest a few modifications to this characterization and raise additional questions. Mule Creek appears to have been occupied at least sporadically throughout the thirteenth century. Based on the presence of ceramic types associated with the Black Mountain or Tularosa phase, Locus A may have been occupied when the immigrants arrived.

The Fornholt site was another sizeable thirteenth century Mule Creek occupation (Dungan 2015). Although a modest number of sherds with production date ranges in the late thirteenth century were recovered from Fornholt, AMS radiocarbon dates from annuals in a room that burned near the time of depopulation suggest this site was probably abandoned before AD 1275, the earliest likely date for the Kayenta arrival in Mule Creek. However, the comparative looseness of the ceramic dating for the thirteenth century occupation of these sites precludes strong inferences about the social context into which these migrants arrived. Current evidence suggests the first Kayenta immigrants to the region may have resettled in an area that was not an empty frontier but that still had a lower population density than the Safford Basin and the San Pedro Valley, where other Kayenta groups relocated.

The population of the Upper Gila increased substantially in the latter half of the 1300s, a demographic effect attributed in the model here to a migration of "Salado" affiliated groups from southeastern Arizona, including the San Pedro Valley, which was experiencing population loss during this interval (Clark and Lyons 2012). These groups would have included both Kayenta descendants and people with various Hohokam affiliations who integrated with them into a new social identified as Salado.

These hybrid groups joined previous Kayenta enclaves that had limited contact with the Hohokam world to form the large, post-AD 1350, Salado sites found along the Upper Gila and its tributaries. This model is currently being evaluated based on work in the Cliff Valley, where many of these late Salado villages are located. An understanding of the occupation sequence at Mule Creek is an important step in evaluating community organization and identity in the wake of these sequential migrations.

OBSIDIAN USE AND CIRCULATION

The ability to source obsidian traded from Mule Creek allows a reconstruction of the social networks along which this material moved. Previous research (Clark and Lyons 2012; Hill et al. 2004) suggests a dispersed Kayenta community in diaspora facilitated the widespread circulation of obsidian in southern Arizona and New Mexico (Mills et al. 2013). The recent work at the 3-Up site suggests this settlement was the major supplier of Mule Creek obsidian throughout the southern southwest during the fourteenth century.

In Mule Creek, obsidian comprised more than 50 percent of the flaked stone assemblage at both 3-Up and nearby Fornholt. In comparison, obsidian in flaked stone assemblages from fourteenth century sites in southeastern Arizona seldom exceeds 10 percent (primarily Kayenta enclaves) and is in the 1–5 percent range for local settlements. In most areas where obsidian is not locally available, this is still an order of magnitude increase from obsidian percentages in sites that predate AD 1300. As expected, of the nearly 2,000 analyzed samples from these two sites, 99 percent were sourced to Mule Creek, with the nearby Gwynn Canyon source present in trace amounts.

Fornholt was a likely supplier of Mule Creek obsidian to sites in the Tularosa area of west-central New Mexico, where material from this source comprises a substantial portion of obsidian. However, Fornholt was depopulated by the late thirteenth century, leaving 3-Up as the only large settlement near the Mule Creek obsidian source. Obsidian procurement increased through time at the 3-Up site, correlating with the increasing frequency of Salado polychrome. Thus, the recent work at 3-Up lends support to a Kayenta/Salado connection in the long distance circulation of Mule Creek obsidian.

CERAMIC PRODUCTION AND CIRCULATION

Neutron Activation Analysis (NAA) and binocular temper identifications were conducted on nearly 500 sherds from the 3-Up site and several others sites in the Upper Gila and Mimbres area (Huntley et al. 2016; Ownby et al. 2014). Neutron Activation Analysis of Salado polychromes and utilitarian wares yielded similar compositional groups from all sampled Upper Gila and Mimbres sites except TJ Ruin and those in the northern Mimbres Valley, suggesting one or more local production centers in Mule Creek, the Cliff Valley, and the Redrock Valley. However, less overall compositional variability was observed in Salado polychromes (except for a few outliers) than in utility wares, suggesting preferential selection of raw materials and more restricted production by fewer potters of these decorated wares. Because the 3-Up site is the only major fourteenth century site in Mule Creek, it is the likely producer for the area. Some Salado polychromes found at TJ Ruin and at northern Mimbres Valley sites were likely made at the 3-Up site.

Binocular temper analysis lends further support to the NAA results for valley level and possibly site level differences in Salado polychrome production. This is based on the variety and size distributions of sand constituents that could be verified through petrographic analysis of a subset of sherds.

Considering the combined NAA and petrographic data, substantial local production of Salado polychromes occurred in all subregions in the Upper Gila and Mimbres study area—including Mule Creek, with 3-Up as the likely producer—except perhaps the northern Mimbres Valley. This pattern of decentralized production has been noted in other areas of the southern Southwest (Clark and Lyons 2012; Crown 1994; Neuzil 2008). Where finer resolution is available, producing settlements or groups of settlements always include at least one probable Kayenta enclave. Some Salado polychrome pottery was exchanged between valleys and basins (for example, from the Cliff Valley to the northern Mimbres Valley), but the scale cannot currently be quantified.

FUTURE RESEARCH QUESTIONS

What was the nature of thirteenth and fourteenth century migration and community organization in the greater Upper Gila region? How did later Salado immigrants from southern Arizona interact with the descendants of Kayenta enclaves in the Upper Gila established a few generations earlier? What were the social connections that led people to aggregate along the Upper Gila, particularly in the Cliff Valley, in the late AD 1300s, and what ultimately caused them to move on? These are only a few of the host of research questions to be addressed in the post-Classic Mimbres period along the Upper Gila and its tributaries. This report represents an attempt to address, or at least to define the parameters of, these issues. These interpretations will be revisited as additional data are collected and more insight into the area is gained.

APPENDIX A

RESULTS OF OBSIDIAN XRF SOURCING AT THE 3-UP SITE, LA 150373, AND THE GAMALSTAD SITE, LA 164472

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Both the 3-Up site, LA 150373, and the Gamalstad site, LA 164472, are located within the primary deposit of the large Mule Creek obsidian source (Figure A.1). Mule Creek obsidian was the dominant raw material used to make flaked stone tools at both sites (also, Chapter 4, this volume).

Considering the large amounts of obsidian recovered from test excavations at the sites, only a fraction of the total assemblage was sourced by XRF. Two sourcing studies were conducted. In all, 70 specimens (35 from each site) were submitted to the Berkeley Archaeological XRF Laboratory as part of a larger sample from multiple sites (Tables A.1–A.2) (Shackley 2010). Relevant portions of that report are presented here.

A much larger sample of obsidian specimens (1,317 specimens from the 3-Up site and 258 specimens from Gamalstad) was submitted to the XRF facility at the Missouri University Research Reactor Laboratory. The results of those analyses are presented and summarized in Tables A.3–A.4. Basic instrumentation and analytical techniques are also presented below. Collaboration between the two studies has led to comparable procedures and reproducible results between the two laboratories.

Despite the discrepancy in sample size between the two studies, the results of the analyses are comparable and only differ in rare sources. Mule Creek obsidian, as expected, was used almost to the exclusion of other obsidian sources. Both studies showed that among the three discernible Mule Creek obsidian source groups (Antelope Creek, North Sawmill Creek, and Mule Mountains), the Antelope Creek source group was the most widely utilized. Obsidian from the Antelope Creek locality also dominates the assemblages of nearly all sites across southeastern Arizona and southwestern New Mexico where Mule Creek obsidian was widely circulated.

Both studies further show that inhabitants of the 3-Up site also utilized significant quantities of obsidian from the North Sawmill Creek locality, and obsidian from this source group was spread relatively evenly among the investigated site loci. Obsidian from the North Sawmill Creek source group did not circulate widely across the southern Southwest and was a rare occurrence at nearby Gamalstad. Trace amounts of obsidian from the Mule Mountains locality was used at both sites.

As expected, exotic obsidian was extremely rare at the two sites and was limited to a few specimens from the nearby Cow Canyon and Ewe/Gwynn Canyon sources, as well as from an unknown source likely located within the San Francisco River or Blue River drainages. The Cow Canyon and "unknown" or San Francisco/Blue source specimens were either from Locus B or Locus C at 3-Up, settlements thought to have been occupied by either Kayenta immigrants (Locus B) from northeastern Arizona or later Salado immigrants from southeastern Arizona (Locus C). The Ewe/Gwynn Canyon specimens were either from Gamalstad or Locus A at 3-Up, both of which were occupied primarily by local groups.

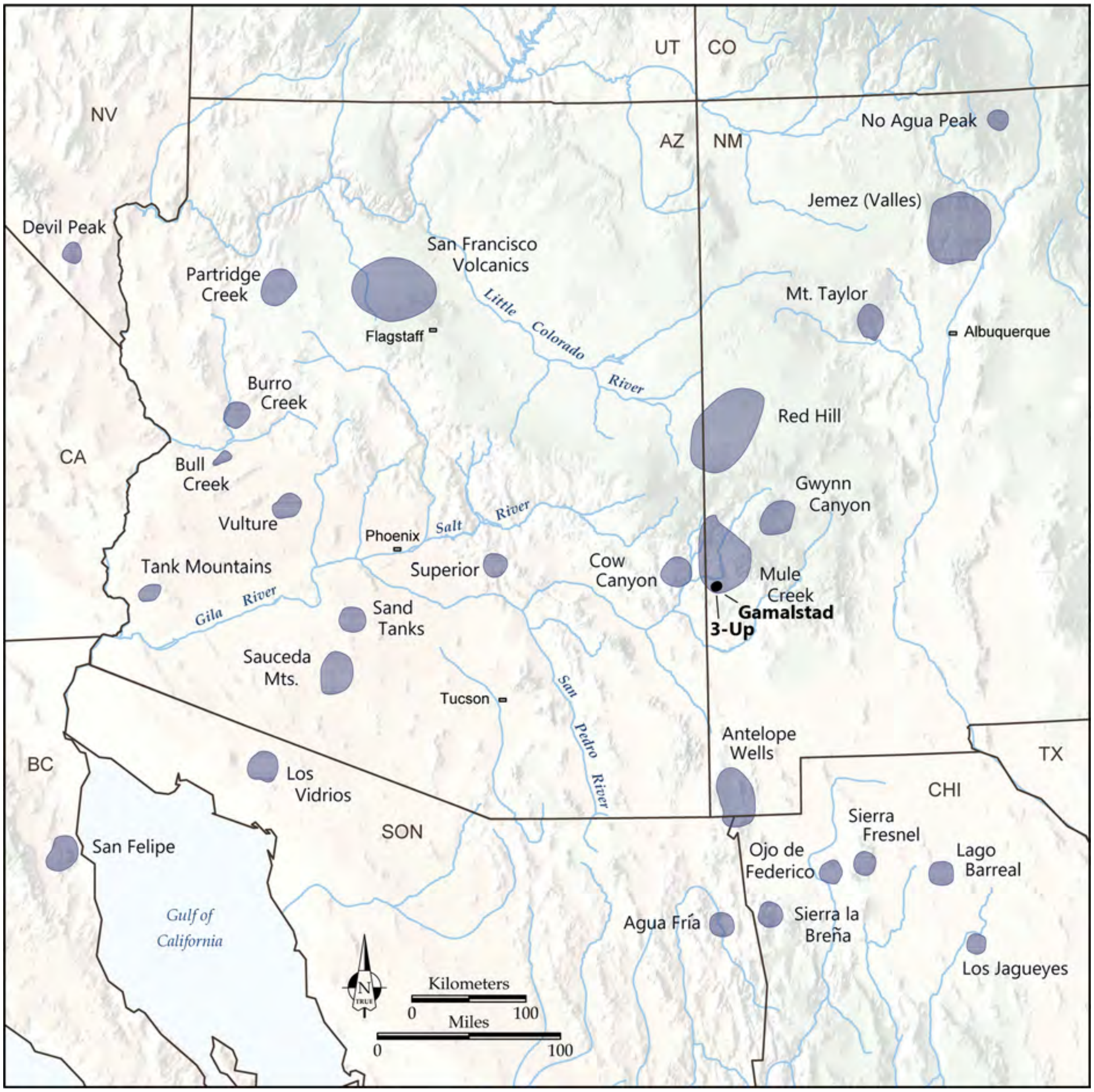

Figure A.1. Map of major obsidian sources utilized during the pre-Hispanic era in the U.S. Southwest.

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The ThermoScientific ARL Quant'X EDXRF was used for the analysis of these artifacts. The instrument has a rhodium-based X-ray tube operated at 35 kV and a thermoelectrically cooled silicon-drift detector. The obsidian calibration uses a set of 37 well-characterized obsidian sources with data from previous ICP, XRF, and NAA measurements (Glascock and Ferguson 2012). The samples were counted for two minutes to measure the minor and trace elements present. The elements measured included Rb, Sr, Y, Zr, and Nb. These five elements are excellent for discriminating most sources.

Statistical analyses were conducted on base-10 logarithms of concentrations. Use of log concentrations rather than raw data compensates for differences in magnitude among the major elements such as iron and trace elements such as niobium. Transformation to base-10 logarithms also yields a more normal distribution for many trace elements.

Table A.1. Results of sourcing for obsidian artifacts from the 3-Up site, LA 150373, and Gamalstad, LA 164472, samples by the Geoarchaeological XRF Laboratory.

Lab Observation No.	Field Season	Field No. (Context)-Observation No.	Source
3-Up, LA 150373			
153	2008	97-1	Blue/San Francisco River
154	2008	97-2	Antelope Creek (Mule Creek)
155	2008	141-1	Antelope Creek (Mule Creek)
156	2008	141-2	Antelope Creek (Mule Creek)
157	2008	141-3	North Sawmill Creek (Mule Creek)
158	2008	261-1	North Sawmill Creek (Mule Creek)
159	2008	204-1	Not obsidian
160	2008	162-1	Antelope Creek (Mule Creek)
161	2008	276-1	Antelope Creek (Mule Creek)
162	2008	228-1	Antelope Creek (Mule Creek)
163	2008	197-1	Antelope Creek (Mule Creek)
164	2008	197-2	Antelope Creek (Mule Creek)
165	2008	197-3	Not obsidian
166	2008	105-1	North Sawmill Creek (Mule Creek)
167	2008	137-1	Antelope Creek (Mule Creek)
168	2008	123-1	Antelope Creek (Mule Creek)
169	2008	123-2	Antelope Creek (Mule Creek)
170	2008	132-1	Antelope Creek (Mule Creek)
171	2008	132-2	Antelope Creek (Mule Creek)
172	2008	132-3	North Sawmill Creek (Mule Creek)
173	2009	277-1	Antelope Creek (Mule Creek)
174	2009	213-1	Antelope Creek (Mule Creek)
175	2009	213-2	North Sawmill Creek (Mule Creek)
176	2009	213-3	Antelope Creek (Mule Creek)
177	2009	213-4	Antelope Creek (Mule Creek)
178	2009	273-1	North Sawmill Creek (Mule Creek)
179	2009	273-2	Gwynn/Ewe Canyon
180	2009	225-1	Antelope Creek (Mule Creek)
181	2009	225-2	Antelope Creek (Mule Creek)
182	2009	225-3	Gwynn/Ewe Canyon
183	2009	225-4	Antelope Creek (Mule Creek)
184	2009	225-5	Antelope Creek (Mule Creek)
185	2009	282-1	Antelope Creek (Mule Creek)
186	2009	282-2	Antelope Creek (Mule Creek)
187	2009	448-1	Mule Mountains (Mule Creek)
Gamalstad, LA 164472			
51	2009	38-1	Antelope Creek (Mule Creek)
52	2009	18-1	Antelope Creek (Mule Creek)
53	2009	126-1	Antelope Creek (Mule Creek)
54	2009	95-1	Antelope Creek (Mule Creek)
55	2009	67-1	Antelope Creek (Mule Creek)
56	2009	67-2	Antelope Creek (Mule Creek)
57	2009	67-3	North Sawmill Creek (Mule Creek)
58	2009	44-1	Antelope Creek (Mule Creek)
59	2009	44-2	Antelope Creek (Mule Creek)
60	2009	44-3	Antelope Creek (Mule Creek)
61	2009	55-1	Antelope Creek (Mule Creek)
62	2009	55-2	Antelope Creek (Mule Creek)
63	2009	416-1	Antelope Creek (Mule Creek)

Table A.1. Continued.

Lab Observation No.	Field Season	Field No. (Context)-Observation No.	Source
64	2009	416-2	Antelope Creek (Mule Creek)
65	2009	416-3	Antelope Creek (Mule Creek)
66	2009	416-4	Antelope Creek (Mule Creek)
67	2009	416-5	Antelope Creek (Mule Creek)
68	2009	68-1	Antelope Creek (Mule Creek)
69	2009	68-2	Antelope Creek (Mule Creek)
70	2009	68-3	Antelope Creek (Mule Creek)
71	2009	374-1	Antelope Creek (Mule Creek)
72	2009	36-1	Antelope Creek (Mule Creek)
73	2009	36-2	Antelope Creek (Mule Creek)
74	2009	29-1	Antelope Creek (Mule Creek)
75	2009	29-2	North Sawmill Creek (Mule Creek)
76	2009	29-3	Antelope Creek (Mule Creek)
77	2009	29-4	Antelope Creek (Mule Creek)
78	2009	29-5	Antelope Creek (Mule Creek)
79	2009	29-6	Gwynn/Ewe Canyon
80	2009	162-1	Antelope Creek (Mule Creek)
81	2009	167-1	Antelope Creek (Mule Creek)
82	2009	167-2	Antelope Creek (Mule Creek)
83	2009	323-1	Antelope Creek (Mule Creek)
84	2009	24-1	Antelope Creek (Mule Creek)
85	2009	81-1	Antelope Creek (Mule Creek)

Table A.2. Summary of XRF Geoarchaeological Laboratory obsidian sourcing results from the 3-Up site, LA 150373, and Gamalstad, LA 164472, by site, source, and source locality.

Site	Antelope Creek (Mule Creek)	N. Sawmill Creek (Mule Creek)	Mule Mountains (Mule Creek)	Blue-San Francisco River	Gwynn/Ewe Canyon	Total
3-Up	23 (70%)	6 (18%)	1 (3%)	1 (3%)	2 (6%)	33 (100%)
Gamalstad	32 (91%)	2 (6%)	0 (0%)	0 (0%)	1 (3%)	35 (100%)
Total	55 (81%)	8 (12%)	1 (1%)	1 (1%)	3 (4%)	68 (99%)

Note: Does not include two submitted samples that were not obsidian.

The interpretation of compositional data obtained from the analysis of archaeological materials is discussed in detail elsewhere (for example, Baxter and Buck 2000; Bieber et al. 1976; Bishop and Neff 1989; Glascock 1992; Harbottle 1976; Neff 2000) and is only summarized here. The main goal of data analysis is to identify distinct homogeneous groups within the analytical database and match these groups to the chemical signatures of known geologic sources. In most cases, source assignments for obsidian artifacts are based on visual inspection of elemental bivariate plots. XRF data tend to skew along correlation lines (largely as a function of variable sample mass), and visual inspection provides more reliable source assignments than some multivariate techniques such as principal component analysis (Ferguson 2012).

Compositional groups can be viewed as "centers of mass" in the compositional hyperspace described by the measured elemental data. Groups are characterized by the locations of their centroids and the unique relationships (that is, correlations) between the elements. Decisions about whether to assign a specimen to a particular compositional group are based on the overall probability that the measured concentrations for the specimen could have been obtained from that group.

Table A.3. XRF obsidian sourcing results from the 3-Up site, LA 150373, and Gamalstad, LA 164472, by the Missouri University Research Reactor (MURR) Laboratory.

Lab Observation No.	Field Season	Field No.	Unit No.	Source
3-Up, LA 150373				
OSN0153	2008	97	–	Mule Creek, Antelope Creek
OSN0154	2008	97	–	Mule Creek, Antelope Creek
OSN0155	2008	141	–	Mule Creek, Antelope Creek
OSN0156	2008	141	–	Mule Creek, Antelope Creek
OSN0157	2008	141	–	Mule Creek, North Sawmill Creek
OSN0158	2008	261	–	Mule Creek, North Sawmill Creek
OSN0159	2008	204	–	Mule Creek, Antelope Creek
OSN0160	2008	162	–	Mule Creek, Antelope Creek
OSN0161	2008	276	–	Mule Creek, Antelope Creek
OSN0162	2008	228	–	Mule Creek, Antelope Creek
OSN0163	2008	197	–	Mule Creek, Antelope Creek
OSN0164	2008	197	–	Mule Creek, Antelope Creek
OSN0165	2008	197	–	Mule Creek, North Sawmill Creek
OSN0166	2008	105	–	Mule Creek, North Sawmill Creek
OSN0167	2008	137	–	Mule Creek, Antelope Creek
OSN0168	2008	123	–	Mule Creek, Antelope Creek
OSN0169	2008	123	–	Mule Creek, Antelope Creek
OSN0170	2008	132	–	Mule Creek, Antelope Creek
OSN0171	2008	132	–	Mule Creek, Antelope Creek
OSN0172	2008	132	–	Mule Creek, North Sawmill Creek
OSN0173	2009	277	–	Mule Creek, Antelope Creek
OSN0174	2009	213	–	Mule Creek, Antelope Creek
OSN0175	2009	213	–	Mule Creek, North Sawmill Creek
OSN0176	2009	213	–	Mule Creek, Antelope Creek
OSN0177	2009	213	–	Mule Creek, Antelope Creek
OSN0178	2009	273	–	Mule Creek, North Sawmill Creek
OSN0179	2009	274	–	Unassigned (too small)
OSN0180	2009	225	–	Mule Creek, Antelope Creek
OSN0181	2009	225	–	Mule Creek, Antelope Creek
OSN0182	2009	225	–	Mule Creek, Antelope Creek
OSN0183	2009	225	–	Mule Creek, Antelope Creek
OSN0184	2009	225	–	Mule Creek, Antelope Creek
OSN0185	2009	282	–	Mule Creek, Antelope Creek
OSN0186	2009	282	–	Mule Creek, Antelope Creek
OSN0187	2009	448	–	Mule Creek, Mule Mountains
OSN1467	2008	3	102	Mule Creek, Antelope Creek
OSN1468	2008	3	102	Mule Creek, Antelope Creek
OSN1469	2008	3	102	Mule Creek, Antelope Creek
OSN1470	2008	3	102	Mule Creek, North Sawmill Creek
OSN1471	2008	3	102	Mule Creek, Antelope Creek
OSN1472	2008	3	102	Mule Creek, Antelope Creek
OSN1473	2008	3	102	Mule Creek, Antelope Creek
OSN1474	2008	3	102	Mule Creek, Antelope Creek
OSN1475	2008	3	102	Mule Creek, Antelope Creek
OSN1476	2008	3	102	Mule Creek, Antelope Creek
OSN1477	2008	3	102	Mule Creek, Antelope Creek
OSN1478	2008	3	102	Mule Creek, Antelope Creek
OSN1479	2008	3	102	Mule Creek, Antelope Creek
OSN1480	2008	3	102	Mule Creek, Antelope Creek
OSN1481	2008	3	102	Mule Creek, Antelope Creek

Table A.3. Continued.

Lab Observation No.	Field Season	Field No.	Unit No.	Source
OSN1482	2008	3	102	Mule Creek, Antelope Creek
OSN1483	2008	3	102	Mule Creek, Antelope Creek
OSN1484	2008	3	102	Mule Creek, Antelope Creek
OSN1485	2008	3	102	Mule Creek, Antelope Creek
OSN1486	2008	3	102	Mule Creek, Antelope Creek
OSN1487	2008	3	102	Mule Creek, Antelope Creek
OSN1488	2008	3	102	Mule Creek, Antelope Creek
OSN1489	2008	3	102	Mule Creek, Antelope Creek
OSN1490	2008	3	102	Mule Creek, Antelope Creek
OSN1491	2008	3	102	Mule Creek, Antelope Creek
OSN1492	2008	4	101	Mule Creek, Antelope Creek
OSN1493	2008	4	101	Mule Creek, Antelope Creek
OSN1494	2008	4	101	Mule Creek, Antelope Creek
OSN1495	2008	4	101	Mule Creek, Antelope Creek
OSN1496	2008	4	101	Unassigned
OSN1497	2008	4	101	Mule Creek, Antelope Creek
OSN1498	2008	4	101	Mule Creek, Antelope Creek
OSN1499	2008	4	101	Mule Creek, Antelope Creek
OSN1500	2008	4	101	Mule Creek, Antelope Creek
OSN1501	2008	4	101	Mule Creek, Antelope Creek
OSN1502	2008	4	101	Mule Creek, North Sawmill Creek
OSN1503	2008	4	101	Mule Creek, Antelope Creek
OSN1504	2008	4	101	Mule Creek, Antelope Creek
OSN1505	2008	4	101	Mule Creek, Antelope Creek
OSN1506	2008	4	101	Mule Creek, Antelope Creek
OSN1507	2008	4	101	Mule Creek, Antelope Creek
OSN1508	2008	4	101	Mule Creek, North Sawmill Creek
OSN1509	2008	4	101	Mule Creek, North Sawmill Creek
OSN1510	2008	4	101	Mule Creek, Antelope Creek
OSN1511	2008	4	101	Mule Creek, Antelope Creek
OSN1512	2008	4	101	Mule Creek, Antelope Creek
OSN1513	2008	4	101	Mule Creek, Antelope Creek
OSN1514	2008	4	101	Mule Creek, Antelope Creek
OSN1515	2008	4	101	Mule Creek, Antelope Creek
OSN1516	2008	4	101	Mule Creek, Antelope Creek
OSN1517	2008	12	102	Mule Creek, North Sawmill Creek
OSN1518	2008	12	102	Mule Creek, Antelope Creek
OSN1519	2008	12	102	Mule Creek, Antelope Creek
OSN1520	2008	12	102	Mule Creek, Antelope Creek
OSN1521	2008	12	102	Mule Creek, North Sawmill Creek
OSN1522	2008	12	102	Mule Creek, Antelope Creek
OSN1523	2008	12	102	Mule Creek, Antelope Creek
OSN1524	2008	12	102	Mule Creek, North Sawmill Creek
OSN1525	2008	12	102	Mule Creek, Antelope Creek
OSN1526	2008	12	102	Mule Creek, Antelope Creek
OSN1527	2008	12	102	Mule Creek, Antelope Creek
OSN1528	2008	12	102	Mule Creek, Antelope Creek
OSN1529	2008	12	102	Mule Creek, Antelope Creek
OSN1530	2008	12	102	Mule Creek, Antelope Creek
OSN1531	2008	12	102	Mule Creek, Antelope Creek
OSN1532	2008	12	102	Mule Creek, Antelope Creek
OSN1533	2008	12	102	Mule Creek, North Sawmill Creek

Table A.3. Continued.

Lab Observation No.	Field Season	Field No.	Unit No.	Source
OSN1534	2008	12	102	Mule Creek, Antelope Creek
OSN1535	2008	12	102	Mule Creek, Antelope Creek
OSN1536	2008	12	102	Mule Creek, Antelope Creek
OSN1537	2008	12	102	Mule Creek, Antelope Creek
OSN1538	2008	12	102	Mule Creek, Antelope Creek
OSN1539	2008	12	102	Mule Creek, Antelope Creek
OSN1540	2008	12	102	Mule Creek, North Sawmill Creek
OSN1541	2008	12	102	Mule Creek, Antelope Creek
OSN1542	2008	15	102	Mule Creek, Antelope Creek
OSN1543	2008	15	102	Mule Creek, Antelope Creek
OSN1544	2008	15	102	Mule Creek, Antelope Creek
OSN1545	2008	15	102	Mule Creek, Antelope Creek
OSN1546	2008	15	102	Mule Creek, Antelope Creek
OSN1547	2008	15	102	Mule Creek, Antelope Creek
OSN1548	2008	15	102	Mule Creek, Antelope Creek
OSN1549	2008	15	102	Mule Creek, Antelope Creek
OSN1550	2008	15	102	Mule Creek, Antelope Creek
OSN1551	2008	15	102	Mule Creek, Antelope Creek
OSN1552	2008	15	102	Mule Creek, Antelope Creek
OSN1553	2008	15	102	Mule Creek, Antelope Creek
OSN1554	2008	15	102	Mule Creek, Antelope Creek
OSN1555	2008	15	102	Mule Creek, Antelope Creek
OSN1556	2008	15	102	Mule Creek, Antelope Creek
OSN1557	2008	15	102	Mule Creek, Antelope Creek
OSN1558	2008	15	102	Mule Creek, Antelope Creek
OSN1559	2008	15	102	Mule Creek, Antelope Creek
OSN1560	2008	15	102	Mule Creek, Antelope Creek
OSN1561	2008	15	102	Mule Creek, Antelope Creek
OSN1562	2008	15	102	Mule Creek, Antelope Creek
OSN1563	2008	15	102	Mule Creek, Antelope Creek
OSN1564	2008	15	102	Mule Creek, Antelope Creek
OSN1565	2008	15	102	Mule Creek, Antelope Creek
OSN1566	2008	15	102	Mule Creek, Antelope Creek
OSN1567	2008	16	102	Mule Creek, Antelope Creek
OSN1568	2008	16	102	Mule Creek, Antelope Creek
OSN1569	2008	16	102	Mule Creek, Antelope Creek
OSN1570	2008	16	102	Mule Creek, Antelope Creek
OSN1571	2008	16	102	Mule Creek, Antelope Creek
OSN1572	2008	16	102	Mule Creek, North Sawmill Creek
OSN1573	2008	22	101	Mule Creek, Antelope Creek
OSN1574	2008	22	101	Mule Creek, Antelope Creek
OSN1575	2008	25	101	Mule Creek, Antelope Creek
OSN1576	2008	25	101	Mule Creek, Antelope Creek
OSN1577	2008	25	101	Mule Creek, North Sawmill Creek
OSN1578	2008	25	101	Mule Creek, Antelope Creek
OSN1579	2008	25	101	Mule Creek, North Sawmill Creek
OSN1580	2008	25	101	Mule Creek, Antelope Creek
OSN1581	2008	25	101	Mule Creek, Antelope Creek
OSN1582	2008	25	101	Mule Creek, North Sawmill Creek
OSN1583	2008	25	101	Mule Creek, Antelope Creek
OSN1584	2008	25	101	Mule Creek, Antelope Creek
OSN1585	2008	25	101	Mule Creek, Antelope Creek

Table A.3. Continued.

Lab Observation No.	Field Season	Field No.	Unit No.	Source
OSN1586	2008	25	101	Mule Creek, Antelope Creek
OSN1587	2008	25	101	Mule Creek, Antelope Creek
OSN1588	2008	25	101	Mule Creek, Antelope Creek
OSN1589	2008	25	101	Mule Creek, Antelope Creek
OSN1590	2008	25	101	Mule Creek, North Sawmill Creek
OSN1591	2008	25	101	Mule Creek, Antelope Creek
OSN1592	2008	25	101	Mule Creek, Antelope Creek
OSN1593	2008	25	101	Mule Creek, Antelope Creek
OSN1594	2008	25	101	Mule Creek, Antelope Creek
OSN1595	2008	25	101	Mule Creek, Antelope Creek
OSN1596	2008	25	101	Mule Creek, Antelope Creek
OSN1597	2008	25	101	Mule Creek, North Sawmill Creek
OSN1598	2008	25	101	Mule Creek, Antelope Creek
OSN1599	2008	25	101	Mule Creek, Antelope Creek
OSN1600	2008	30	101	Mule Creek, Antelope Creek
OSN1601	2008	30	101	Mule Creek, Antelope Creek
OSN1602	2008	30	101	Mule Creek, Antelope Creek
OSN1603	2008	30	101	Mule Creek, Antelope Creek
OSN1604	2008	30	101	Mule Creek, Antelope Creek
OSN1605	2008	30	101	Mule Creek, Antelope Creek
OSN1606	2008	30	101	Mule Creek, North Sawmill Creek
OSN1607	2008	30	101	Mule Creek, Antelope Creek
OSN1608	2008	30	101	Mule Creek, Antelope Creek
OSN1609	2008	30	101	Mule Creek, Antelope Creek
OSN1610	2008	30	101	Mule Creek, Antelope Creek
OSN1611	2008	30	101	Mule Creek, Antelope Creek
OSN1612	2008	30	101	Mule Creek, Antelope Creek
OSN1613	2008	30	101	Mule Creek, North Sawmill Creek
OSN1614	2008	30	101	Mule Creek, Antelope Creek
OSN1615	2008	30	101	Mule Creek, Antelope Creek
OSN1616	2008	30	101	Mule Creek, Antelope Creek
OSN1617	2008	30	101	Mule Creek, Antelope Creek
OSN1618	2008	30	101	Mule Creek, Antelope Creek
OSN1619	2008	30	101	Mule Creek, North Sawmill Creek
OSN1620	2008	30	101	Mule Creek, Antelope Creek
OSN1621	2008	30	101	Mule Creek, Antelope Creek
OSN1622	2008	30	101	Mule Creek, Antelope Creek
OSN1623	2008	30	101	Mule Creek, Antelope Creek
OSN1624	2008	30	101	Mule Creek, Antelope Creek
OSN1625	2008	33	101	Mule Creek, Antelope Creek
OSN1626	2008	33	101	Mule Creek, Antelope Creek
OSN1627	2008	33	101	Mule Creek, Antelope Creek
OSN1628	2008	33	101	Mule Creek, Antelope Creek
OSN1629	2008	33	101	Mule Creek, Antelope Creek
OSN1630	2008	33	101	Mule Creek, Antelope Creek
OSN1631	2008	33	101	Mule Creek, Antelope Creek
OSN1632	2008	33	101	Mule Creek, Antelope Creek
OSN1633	2008	33	101	Mule Creek, Antelope Creek
OSN1634	2008	33	101	Mule Creek, Antelope Creek
OSN1635	2008	33	101	Mule Creek, Antelope Creek
OSN1636	2008	33	101	Mule Creek, Antelope Creek
OSN1637	2008	33	101	Mule Creek, North Sawmill Creek

Table A.3. Continued.

Lab Observation No.	Field Season	Field No.	Unit No.	Source
OSN1638	2008	33	101	Mule Creek, Antelope Creek
OSN1639	2008	33	101	Mule Creek, Antelope Creek
OSN1640	2008	33	101	Mule Creek, Antelope Creek
OSN1641	2008	33	101	Mule Creek, Antelope Creek
OSN1642	2008	33	101	Mule Creek, Antelope Creek
OSN1643	2008	33	101	Mule Creek, Antelope Creek
OSN1644	2008	33	101	Mule Creek, Antelope Creek
OSN1645	2008	33	101	Mule Creek, Antelope Creek
OSN1646	2008	33	101	Mule Creek, Antelope Creek
OSN1647	2008	33	101	Mule Creek, Antelope Creek
OSN1648	2008	33	101	Mule Creek, Antelope Creek
OSN1649	2008	33	101	Mule Creek, Antelope Creek
OSN1650	2008	39	101	Mule Creek, North Sawmill Creek
OSN1651	2008	39	101	Mule Creek, North Sawmill Creek
OSN1652	2008	39	101	Mule Creek, Antelope Creek
OSN1653	2008	39	101	Mule Creek, Mule Mountains
OSN1654	2008	39	101	Mule Creek, Antelope Creek
OSN1655	2008	39	101	Mule Creek, Antelope Creek
OSN1656	2008	39	101	Mule Creek, Antelope Creek
OSN1657	2008	39	101	Mule Creek, Antelope Creek
OSN1658	2008	39	101	Mule Creek, Antelope Creek
OSN1659	2008	39	101	Mule Creek, Antelope Creek
OSN1660	2008	39	101	Mule Creek, Antelope Creek
OSN1661	2008	39	101	Mule Creek, Antelope Creek
OSN1662	2008	39	101	Mule Creek, Antelope Creek
OSN1663	2008	39	101	Mule Creek, Antelope Creek
OSN1664	2008	39	101	Mule Creek, Antelope Creek
OSN1665	2008	39	101	Mule Creek, Antelope Creek
OSN1666	2008	39	101	Mule Creek, Antelope Creek
OSN1667	2008	39	101	Mule Creek, Antelope Creek
OSN1668	2008	39	101	Mule Creek, Antelope Creek
OSN1669	2008	39	101	Mule Creek, North Sawmill Creek
OSN1670	2008	39	101	Mule Creek, Antelope Creek
OSN1671	2008	39	101	Mule Creek, North Sawmill Creek
OSN1672	2008	39	101	Mule Creek, Antelope Creek
OSN1673	2008	39	101	Mule Creek, Antelope Creek
OSN1674	2008	39	101	Mule Creek, Antelope Creek
OSN1675	2008	46	101	Mule Creek, North Sawmill Creek
OSN1676	2008	46	101	Mule Creek, North Sawmill Creek
OSN1677	2008	46	101	Mule Creek, Antelope Creek
OSN1678	2008	46	101	Mule Creek, Antelope Creek
OSN1679	2008	46	101	Mule Creek, Antelope Creek
OSN1680	2008	46	101	Mule Creek, Antelope Creek
OSN1681	2008	46	101	Mule Creek, Antelope Creek
OSN1682	2008	46	101	Mule Creek, Antelope Creek
OSN1683	2008	46	101	Mule Creek, Antelope Creek
OSN1684	2008	46	101	Mule Creek, North Sawmill Creek
OSN1685	2008	46	101	Mule Creek, Antelope Creek
OSN1686	2008	46	101	Mule Creek, Antelope Creek
OSN1687	2008	46	101	Mule Creek, Antelope Creek
OSN1688	2008	46	101	Mule Creek, Antelope Creek
OSN1689	2008	46	101	Mule Creek, Antelope Creek

Table A.3. Continued.

Lab Observation No.	Field Season	Field No.	Unit No.	Source
OSN1690	2008	46	101	Mule Creek, North Sawmill Creek
OSN1691	2008	46	101	Mule Creek, Antelope Creek
OSN1692	2008	46	101	Mule Creek, Antelope Creek
OSN1693	2008	46	101	Mule Creek, Antelope Creek
OSN1694	2008	46	101	Mule Creek, Antelope Creek
OSN1695	2008	46	101	Mule Creek, Antelope Creek
OSN1696	2008	46	101	Mule Creek, Antelope Creek
OSN1697	2008	46	101	Mule Creek, North Sawmill Creek
OSN1698	2008	46	101	Mule Creek, Antelope Creek
OSN1699	2008	46	101	Mule Creek, Antelope Creek
OSN1700	2008	48	102	Mule Creek, Antelope Creek
OSN1701	2008	48	102	Mule Creek, Antelope Creek
OSN1702	2008	48	102	Mule Creek, Antelope Creek
OSN1703	2008	48	102	Mule Creek, Antelope Creek
OSN1704	2008	48	102	Mule Creek, Antelope Creek
OSN1705	2008	48	102	Mule Creek, North Sawmill Creek
OSN1706	2008	48	102	Mule Creek, North Sawmill Creek
OSN1707	2008	48	102	Mule Creek, Antelope Creek
OSN1708	2008	48	102	Mule Creek, Antelope Creek
OSN1709	2008	48	102	Mule Creek, Antelope Creek
OSN1710	2008	49	103	Mule Creek, Antelope Creek
OSN1711	2008	49	103	Mule Creek, Antelope Creek
OSN1712	2008	49	103	Mule Creek, Antelope Creek
OSN1713	2008	49	103	Mule Creek, North Sawmill Creek
OSN1714	2008	49	103	Mule Creek, Antelope Creek
OSN1715	2008	49	103	Mule Creek, North Sawmill Creek
OSN1716	2008	49	103	Mule Creek, Antelope Creek
OSN1717	2008	49	103	Mule Creek, North Sawmill Creek
OSN1718	2008	49	103	Mule Creek, Antelope Creek
OSN1719	2008	49	103	Mule Creek, Antelope Creek
OSN1720	2008	49	103	Mule Creek, Antelope Creek
OSN1721	2008	49	103	Mule Creek, Antelope Creek
OSN1722	2008	49	103	Mule Creek, Antelope Creek
OSN1723	2008	49	103	Mule Creek, Antelope Creek
OSN1724	2008	49	103	Mule Creek, Antelope Creek
OSN1725	2008	49	103	Mule Creek, Antelope Creek
OSN1726	2008	49	103	Mule Creek, Antelope Creek
OSN1727	2008	49	103	Mule Creek, Antelope Creek
OSN1728	2008	49	103	Mule Creek, Antelope Creek
OSN1729	2008	49	103	Mule Creek, North Sawmill Creek
OSN1730	2008	49	103	Mule Creek, Antelope Creek
OSN1731	2008	49	103	Mule Creek, Antelope Creek
OSN1732	2008	49	103	Mule Creek, North Sawmill Creek
OSN1733	2008	49	103	Mule Creek, Antelope Creek
OSN1734	2008	49	103	Mule Creek, Antelope Creek
OSN1735	2008	56	102	Mule Creek, Antelope Creek
OSN1736	2008	56	102	Mule Creek, Antelope Creek
OSN1737	2008	56	102	Mule Creek, Antelope Creek
OSN1738	2008	56	102	Mule Creek, Antelope Creek
OSN1739	2008	56	102	Mule Creek, Antelope Creek
OSN1740	2008	56	102	Mule Creek, Antelope Creek
OSN1741	2008	56	102	Mule Creek, Antelope Creek

Table A.3. Continued.

Lab Observation No.	Field Season	Field No.	Unit No.	Source
OSN1742	2008	56	102	Mule Creek, Antelope Creek
OSN1743	2008	56	102	Mule Creek, North Sawmill Creek
OSN1744	2008	56	102	Mule Creek, Antelope Creek
OSN1745	2008	56	102	Mule Creek, Antelope Creek
OSN1746	2008	56	102	Mule Creek, Antelope Creek
OSN1747	2008	56	102	Mule Creek, Antelope Creek
OSN1748	2008	56	102	Mule Creek, Antelope Creek
OSN1749	2008	56	102	Mule Creek, North Sawmill Creek
OSN1750	2008	56	102	Mule Creek, Antelope Creek
OSN1751	2008	56	102	Mule Creek, Antelope Creek
OSN1752	2008	56	102	Mule Creek, Antelope Creek
OSN1753	2008	56	102	Mule Creek, Antelope Creek
OSN1754	2008	56	102	Mule Creek, Antelope Creek
OSN1755	2008	56	102	Mule Creek, Antelope Creek
OSN1756	2008	56	102	Mule Creek, Antelope Creek
OSN1757	2008	56	102	Mule Creek, Antelope Creek
OSN1758	2008	56	102	Mule Creek, Antelope Creek
OSN1759	2008	56	102	Mule Creek, Antelope Creek
OSN1760	2008	67	103	Mule Creek, Antelope Creek
OSN1761	2008	67	103	Mule Creek, North Sawmill Creek
OSN1762	2008	67	103	Mule Creek, Antelope Creek
OSN1763	2008	67	103	Mule Creek, Antelope Creek
OSN1764	2008	67	103	Mule Creek, North Sawmill Creek
OSN1765	2008	67	103	Mule Creek, North Sawmill Creek
OSN1766	2008	67	103	Mule Creek, North Sawmill Creek
OSN1767	2008	67	103	Mule Creek, North Sawmill Creek
OSN1768	2008	67	103	Mule Creek, Antelope Creek
OSN1769	2008	67	103	Mule Creek, Antelope Creek
OSN1770	2008	67	103	Mule Creek, Antelope Creek
OSN1771	2008	67	103	Mule Creek, Antelope Creek
OSN1772	2008	67	103	Mule Creek, North Sawmill Creek
OSN1773	2008	67	103	Mule Creek, North Sawmill Creek
OSN1774	2008	67	103	Mule Creek, Antelope Creek
OSN1775	2008	67	103	Mule Creek, Antelope Creek
OSN1776	2008	67	103	Mule Creek, Antelope Creek
OSN1777	2008	67	103	Mule Creek, Antelope Creek
OSN1778	2008	67	103	Mule Creek, Antelope Creek
OSN1779	2008	67	103	Mule Creek, North Sawmill Creek
OSN1780	2008	67	103	Mule Creek, Antelope Creek
OSN1781	2008	67	103	Mule Creek, Antelope Creek
OSN1782	2008	67	103	Mule Creek, Antelope Creek
OSN1783	2008	67	103	Mule Creek, Antelope Creek
OSN1784	2008	67	103	Mule Creek, Antelope Creek
OSN1785	2008	76	103	Mule Creek, Antelope Creek
OSN1786	2008	76	103	Mule Creek, Antelope Creek
OSN1787	2008	76	103	Mule Creek, Antelope Creek
OSN1788	2008	76	103	Mule Creek, Antelope Creek
OSN1789	2008	76	103	Mule Creek, Antelope Creek
OSN1790	2008	76	103	Mule Creek, Antelope Creek
OSN1791	2008	76	103	Mule Creek, Antelope Creek
OSN1792	2008	80	103	Mule Creek, North Sawmill Creek
OSN1793	2008	80	103	Mule Creek, Antelope Creek

Table A.3. Continued.

Lab Observation No.	Field Season	Field No.	Unit No.	Source
OSN1794	2008	80	103	Mule Creek, Antelope Creek
OSN1795	2008	80	103	Mule Creek, North Sawmill Creek
OSN1796	2008	80	103	Mule Creek, Antelope Creek
OSN1797	2008	80	103	Mule Creek, North Sawmill Creek
OSN1798	2008	80	103	Mule Creek, Antelope Creek
OSN1799	2008	80	103	Mule Creek, Antelope Creek
OSN1800	2008	80	103	Mule Creek, Antelope Creek
OSN1801	2008	80	103	Mule Creek, Antelope Creek
OSN1802	2008	82	103	Mule Creek, Antelope Creek
OSN1803	2008	82	103	Mule Creek, Antelope Creek
OSN1804	2008	82	103	Mule Creek, Antelope Creek
OSN1805	2008	82	103	Mule Creek, Antelope Creek
OSN1806	2008	82	103	Mule Creek, Antelope Creek
OSN1807	2008	82	103	Mule Creek, Antelope Creek
OSN1808	2008	82	103	Mule Creek, Antelope Creek
OSN1809	2008	82	103	Mule Creek, North Sawmill Creek
OSN1810	2008	93	104	Mule Creek, Antelope Creek
OSN1811	2008	93	104	Mule Creek, Antelope Creek
OSN1812	2008	93	104	Mule Creek, Antelope Creek
OSN1813	2008	93	104	Mule Creek, Antelope Creek
OSN1814	2008	93	104	Mule Creek, North Sawmill Creek
OSN1815	2008	93	104	Mule Creek, Antelope Creek
OSN1816	2008	93	104	Mule Creek, Antelope Creek
OSN1817	2008	93	104	Mule Creek, Antelope Creek
OSN1818	2008	93	104	Mule Creek, Antelope Creek
OSN1819	2008	93	104	Mule Creek, North Sawmill Creek
OSN1820	2008	93	104	Mule Creek, North Sawmill Creek
OSN1821	2008	93	104	Mule Creek, Antelope Creek
OSN1822	2008	93	104	Mule Creek, Antelope Creek
OSN1823	2008	93	104	Mule Creek, North Sawmill Creek
OSN1824	2008	93	104	Mule Creek, Antelope Creek
OSN1825	2008	93	104	Mule Creek, North Sawmill Creek
OSN1826	2008	93	104	Mule Creek, Antelope Creek
OSN1827	2008	93	104	Mule Creek, Antelope Creek
OSN1828	2008	93	104	Mule Creek, Antelope Creek
OSN1829	2008	93	104	Mule Creek, Antelope Creek
OSN1830	2008	93	104	Mule Creek, Antelope Creek
OSN1831	2008	93	104	Mule Creek, North Sawmill Creek
OSN1832	2008	93	104	Mule Creek, Antelope Creek
OSN1833	2008	93	104	Mule Creek, North Sawmill Creek
OSN1834	2008	93	104	Mule Creek, Antelope Creek
OSN1835	2008	95	104	Mule Creek, Antelope Creek
OSN1836	2008	95	104	Mule Creek, Antelope Creek
OSN1837	2008	95	104	Mule Creek, Antelope Creek
OSN1838	2008	95	104	Mule Creek, Antelope Creek
OSN1839	2008	95	104	Mule Creek, Antelope Creek
OSN1840	2008	95	104	Mule Creek, Antelope Creek
OSN1841	2008	95	104	Mule Creek, Antelope Creek
OSN1842	2008	95	104	Mule Creek, Antelope Creek
OSN1843	2008	95	104	Cow Canyon
OSN1844	2008	95	104	Mule Creek, Antelope Creek
OSN1845	2008	95	104	Mule Creek, Antelope Creek

Table A.3. Continued.

Lab Observation No.	Field Season	Field No.	Unit No.	Source
OSN1846	2008	95	104	Mule Creek, North Sawmill Creek
OSN1847	2008	95	104	Mule Creek, Antelope Creek
OSN1848	2008	95	104	Mule Creek, Antelope Creek
OSN1849	2008	95	104	Mule Creek, Antelope Creek
OSN1850	2008	95	104	Mule Creek, Antelope Creek
OSN1851	2008	95	104	Not obsidian
OSN1852	2008	95	104	Mule Creek, Antelope Creek
OSN1853	2008	95	104	Mule Creek, North Sawmill Creek
OSN1854	2008	95	104	Mule Creek, Antelope Creek
OSN1855	2008	95	104	Mule Creek, North Sawmill Creek
OSN1856	2008	95	104	Mule Creek, Antelope Creek
OSN1857	2008	95	104	Mule Creek, North Sawmill Creek
OSN1858	2008	95	104	Mule Creek, North Sawmill Creek
OSN1859	2008	95	104	Mule Creek, Antelope Creek
OSN1860	2008	97	104	Mule Creek, Antelope Creek
OSN1861	2008	97	104	Mule Creek, Antelope Creek
OSN1862	2008	97	104	Mule Creek, North Sawmill Creek
OSN1863	2008	97	104	Mule Creek, Antelope Creek
OSN1864	2008	97	104	Mule Creek, North Sawmill Creek
OSN1865	2008	97	104	Mule Creek, Antelope Creek
OSN1866	2008	97	104	Mule Creek, Antelope Creek
OSN1867	2008	97	104	Mule Creek, Antelope Creek
OSN1868	2008	97	104	Mule Creek, North Sawmill Creek
OSN1869	2008	97	104	Mule Creek, Antelope Creek
OSN1870	2008	97	104	Mule Creek, Antelope Creek
OSN1871	2008	97	104	Mule Creek, Antelope Creek
OSN1872	2008	97	104	Mule Creek, Antelope Creek
OSN1873	2008	97	104	Mule Creek, Antelope Creek
OSN1874	2008	97	104	Mule Creek, North Sawmill Creek
OSN1875	2008	97	104	Mule Creek, Antelope Creek
OSN1876	2008	97	104	Mule Creek, Antelope Creek
OSN1877	2008	97	104	Mule Creek, Antelope Creek
OSN1878	2008	97	104	Mule Creek, North Sawmill Creek
OSN1879	2008	97	104	Mule Creek, North Sawmill Creek
OSN1880	2008	97	104	Not obsidian
OSN1881	2008	105	104	Mule Creek, Antelope Creek
OSN1882	2008	105	104	Mule Creek, Antelope Creek
OSN1883	2008	105	104	Mule Creek, Antelope Creek
OSN1884	2008	105	104	Mule Creek, North Sawmill Creek
OSN1885	2008	105	104	Mule Creek, Antelope Creek
OSN1886	2008	105	104	Mule Creek, North Sawmill Creek
OSN1887	2008	105	104	Mule Creek, Antelope Creek
OSN1888	2008	105	104	Mule Creek, Antelope Creek
OSN1889	2008	105	104	Mule Creek, North Sawmill Creek
OSN1890	2008	105	104	Mule Creek, Antelope Creek
OSN1891	2008	105	104	Mule Creek, Antelope Creek
OSN1892	2008	105	104	Mule Creek, Antelope Creek
OSN1893	2008	105	104	Mule Creek, Antelope Creek
OSN1894	2008	105	104	Mule Creek, Antelope Creek
OSN1895	2008	105	104	Mule Creek, Antelope Creek
OSN1896	2008	105	104	Mule Creek, Antelope Creek
OSN1897	2008	105	104	Mule Creek, North Sawmill Creek

Table A.3. Continued.

Lab Observation No.	Field Season	Field No.	Unit No.	Source
OSN1898	2008	105	104	Mule Creek, North Sawmill Creek
OSN1899	2008	105	104	Mule Creek, North Sawmill Creek
OSN1900	2008	105	104	Mule Creek, Antelope Creek
OSN1901	2008	105	104	Mule Creek, Mule Mountains
OSN1902	2008	105	104	Mule Creek, North Sawmill Creek
OSN1903	2008	105	104	Mule Creek, Antelope Creek
OSN1904	2008	105	104	Mule Creek, Antelope Creek
OSN1905	2008	105	104	Mule Creek, Antelope Creek
OSN1906	2008	112	105	Mule Creek, Antelope Creek
OSN1907	2008	112	105	Mule Creek, North Sawmill Creek
OSN1908	2008	112	105	Mule Creek, Antelope Creek
OSN1909	2008	112	105	Mule Creek, Antelope Creek
OSN1910	2008	112	105	Mule Creek, Antelope Creek
OSN1911	2008	112	105	Mule Creek, North Sawmill Creek
OSN1912	2008	112	105	Mule Creek, Antelope Creek
OSN1913	2008	112	105	Mule Creek, Antelope Creek
OSN1914	2008	112	105	Mule Creek, Antelope Creek
OSN1915	2008	112	105	Mule Creek, Antelope Creek
OSN1916	2008	112	105	Mule Creek, Antelope Creek
OSN1917	2008	112	105	Mule Creek, North Sawmill Creek
OSN1918	2008	112	105	Mule Creek, Antelope Creek
OSN1919	2008	112	105	Mule Creek, Antelope Creek
OSN1920	2008	112	105	Mule Creek, Antelope Creek
OSN1921	2008	112	105	Mule Creek, Antelope Creek
OSN1922	2008	112	105	Mule Creek, North Sawmill Creek
OSN1923	2008	112	105	Mule Creek, Antelope Creek
OSN1924	2008	112	105	Mule Creek, Antelope Creek
OSN1925	2008	112	105	Mule Creek, Antelope Creek
OSN1926	2008	112	105	Mule Creek, Antelope Creek
OSN1927	2008	112	105	Mule Creek, North Sawmill Creek
OSN1928	2008	112	105	Mule Creek, Antelope Creek
OSN1929	2008	112	105	Mule Creek, Antelope Creek
OSN1930	2008	112	105	Not obsidian
OSN1931	2008	117	104	Mule Creek, Antelope Creek
OSN1932	2008	117	104	Mule Creek, North Sawmill Creek
OSN1933	2008	117	104	Mule Creek, Antelope Creek
OSN1934	2008	117	104	Mule Creek, Antelope Creek
OSN1935	2008	117	104	Mule Creek, Antelope Creek
OSN1936	2008	117	104	Mule Creek, Antelope Creek
OSN1937	2008	117	104	Mule Creek, Antelope Creek
OSN1938	2008	117	104	Mule Creek, Antelope Creek
OSN1939	2008	117	104	Mule Creek, Antelope Creek
OSN1940	2008	117	104	Mule Creek, North Sawmill Creek
OSN1941	2008	117	104	Mule Creek, Antelope Creek
OSN1942	2008	117	104	Unassigned
OSN1943	2008	117	104	Mule Creek, Antelope Creek
OSN1944	2008	117	104	Mule Creek, North Sawmill Creek
OSN1945	2008	117	104	Mule Creek, North Sawmill Creek
OSN1946	2008	117	104	Mule Creek, North Sawmill Creek
OSN1947	2008	117	104	Mule Creek, Antelope Creek
OSN1948	2008	117	104	Mule Creek, Antelope Creek
OSN1949	2008	117	104	Mule Creek, Antelope Creek

Table A.3. Continued.

Lab Observation No.	Field Season	Field No.	Unit No.	Source
OSN1950	2008	117	104	Mule Creek, Antelope Creek
OSN1951	2008	123	104	Mule Creek, Antelope Creek
OSN1952	2008	123	104	Mule Creek, Antelope Creek
OSN1953	2008	123	104	Mule Creek, Antelope Creek
OSN1954	2008	123	104	Mule Creek, North Sawmill Creek
OSN1955	2008	123	104	Mule Mountains
OSN1956	2008	123	104	Mule Creek, Antelope Creek
OSN1957	2008	123	104	Mule Creek, Antelope Creek
OSN1958	2008	123	104	Mule Creek, Antelope Creek
OSN1959	2008	123	104	Mule Creek, Antelope Creek
OSN1960	2008	123	104	Mule Creek, North Sawmill Creek
OSN1961	2008	123	104	Mule Creek, Antelope Creek
OSN1962	2008	123	104	Mule Creek, Antelope Creek
OSN1963	2008	123	104	Mule Creek, Antelope Creek
OSN1964	2008	123	104	Mule Creek, Antelope Creek
OSN1965	2008	123	104	Mule Creek, Antelope Creek
OSN1966	2008	123	104	Mule Creek, Antelope Creek
OSN1967	2008	123	104	Mule Creek, North Sawmill Creek
OSN1968	2008	123	104	Mule Creek, Antelope Creek
OSN1969	2008	123	104	Mule Creek, North Sawmill Creek
OSN1970	2008	123	104	Mule Creek, Antelope Creek
OSN1971	2008	123	104	Mule Creek, North Sawmill Creek
OSN1972	2008	123	104	Mule Creek, Antelope Creek
OSN1973	2008	123	104	Mule Creek, Antelope Creek
OSN1974	2008	123	104	Mule Creek, Antelope Creek
OSN1975	2008	123	104	Mule Creek, North Sawmill Creek
OSN1976	2008	132	105	Mule Creek, North Sawmill Creek
OSN1977	2008	132	105	Mule Creek, Antelope Creek
OSN1978	2008	132	105	Mule Creek, North Sawmill Creek
OSN1979	2008	132	105	Mule Creek, Antelope Creek
OSN1980	2008	132	105	Mule Creek, North Sawmill Creek
OSN1981	2008	132	105	Mule Creek, Antelope Creek
OSN1982	2008	132	105	Mule Mountains
OSN1983	2008	132	105	Mule Creek, Antelope Creek
OSN1984	2008	132	105	Mule Creek, Antelope Creek
OSN1985	2008	132	105	Mule Creek, Antelope Creek
OSN1986	2008	132	105	Mule Creek, Antelope Creek
OSN1987	2008	132	105	Mule Creek, Antelope Creek
OSN1988	2008	132	105	Mule Creek, Antelope Creek
OSN1989	2008	132	105	Mule Creek, Antelope Creek
OSN1990	2008	132	105	Mule Creek, Antelope Creek
OSN1991	2008	132	105	Mule Creek, Antelope Creek
OSN1992	2008	132	105	Mule Creek, North Sawmill Creek
OSN1993	2008	132	105	Mule Creek, Antelope Creek
OSN1994	2008	132	105	Mule Creek, Antelope Creek
OSN1995	2008	132	105	Mule Creek, North Sawmill Creek
OSN1996	2008	132	105	Mule Creek, Antelope Creek
OSN1997	2008	132	105	Mule Creek, Antelope Creek
OSN1998	2008	132	105	Mule Creek, Antelope Creek
OSN1999	2008	132	105	Mule Creek, Antelope Creek
OSN2000	2008	132	105	Mule Creek, Antelope Creek
OSN2001	2008	137	105	Mule Creek, Antelope Creek

Table A.3. Continued.

Lab Observation No.	Field Season	Field No.	Unit No.	Source
OSN2002	2008	137	105	Mule Creek, Antelope Creek
OSN2003	2008	137	105	Mule Creek, Antelope Creek
OSN2004	2008	137	105	Mule Creek, North Sawmill Creek
OSN2005	2008	137	105	Mule Creek, Antelope Creek
OSN2006	2008	137	105	Unknown 1
OSN2007	2008	137	105	Mule Creek, Antelope Creek
OSN2008	2008	137	105	Mule Creek, Antelope Creek
OSN2009	2008	137	105	Mule Creek, Antelope Creek
OSN2010	2008	137	105	Mule Creek, Antelope Creek
OSN2011	2008	137	105	Mule Creek, Antelope Creek
OSN2012	2008	137	105	Mule Creek, Antelope Creek
OSN2013	2008	137	105	Mule Creek, North Sawmill Creek
OSN2014	2008	137	105	Mule Creek, Antelope Creek
OSN2015	2008	137	105	Mule Creek, Antelope Creek
OSN2016	2008	137	105	Mule Creek, Antelope Creek
OSN2017	2008	137	105	Mule Creek, Antelope Creek
OSN2018	2008	137	105	Mule Creek, North Sawmill Creek
OSN2019	2008	137	105	Mule Creek, Antelope Creek
OSN2020	2008	137	105	Mule Creek, Antelope Creek
OSN2021	2008	137	105	Mule Creek, Antelope Creek
OSN2022	2008	137	105	Mule Creek, Antelope Creek
OSN2023	2008	137	105	Mule Creek, North Sawmill Creek
OSN2024	2008	137	105	Mule Creek, North Sawmill Creek
OSN2025	2008	137	105	Mule Creek, Antelope Creek
OSN2026	2008	141	105	Mule Creek, Antelope Creek
OSN2027	2008	141	105	Mule Creek, Antelope Creek
OSN2028	2008	141	105	Mule Creek, Antelope Creek
OSN2029	2008	141	105	Mule Creek, Antelope Creek
OSN2030	2008	141	105	Mule Creek, North Sawmill Creek
OSN2031	2008	141	105	Mule Creek, Antelope Creek
OSN2032	2008	141	105	Mule Creek, Antelope Creek
OSN2033	2008	141	105	Mule Creek, Antelope Creek
OSN2034	2008	141	105	Mule Creek, Antelope Creek
OSN2035	2008	141	105	Mule Creek, Antelope Creek
OSN2036	2008	141	105	Mule Creek, North Sawmill Creek
OSN2037	2008	141	105	Mule Creek, Antelope Creek
OSN2038	2008	141	105	Mule Creek, North Sawmill Creek
OSN2039	2008	141	105	Mule Creek, Antelope Creek
OSN2040	2008	141	105	Mule Creek, Antelope Creek
OSN2041	2008	141	105	Mule Creek, Antelope Creek
OSN2042	2008	141	105	Mule Creek, Antelope Creek
OSN2043	2008	141	105	Mule Creek, Antelope Creek
OSN2044	2008	141	105	Mule Creek, Antelope Creek
OSN2045	2008	141	105	Mule Creek, Antelope Creek
OSN2046	2008	141	105	Mule Creek, Antelope Creek
OSN2047	2008	141	105	Mule Creek, North Sawmill Creek
OSN2048	2008	141	105	Mule Creek, Antelope Creek
OSN2049	2008	141	105	Mule Creek, Antelope Creek
OSN2050	2008	141	105	Mule Creek, Antelope Creek
OSN2051	2008	147	104	Mule Creek, North Sawmill Creek
OSN2052	2008	147	104	Mule Creek, Antelope Creek
OSN2053	2008	147	104	Mule Creek, Antelope Creek

Table A.3. Continued.

Lab Observation No.	Field Season	Field No.	Unit No.	Source
OSN2054	2008	147	104	Mule Creek, Antelope Creek
OSN2055	2008	147	104	Mule Creek, Antelope Creek
OSN2056	2008	147	104	Mule Creek, Antelope Creek
OSN2057	2008	147	104	Mule Creek, Antelope Creek
OSN2058	2008	147	104	Mule Creek, Antelope Creek
OSN2059	2008	147	104	Mule Creek, North Sawmill Creek
OSN2060	2008	147	104	Mule Creek, Antelope Creek
OSN2061	2008	147	104	Mule Creek, North Sawmill Creek
OSN2062	2008	147	104	Mule Creek, Antelope Creek
OSN2063	2008	147	104	Mule Creek, Antelope Creek
OSN2064	2008	147	104	Mule Creek, Antelope Creek
OSN2065	2008	147	104	Mule Creek, North Sawmill Creek
OSN2066	2008	147	104	Mule Creek, Antelope Creek
OSN2067	2008	147	104	Mule Creek, Antelope Creek
OSN2068	2008	147	104	Mule Creek, Antelope Creek
OSN2069	2008	147	104	Mule Creek, Antelope Creek
OSN2070	2008	147	104	Mule Creek, Antelope Creek
OSN2071	2008	147	104	Mule Creek, Antelope Creek
OSN2072	2008	154	104	Mule Creek, Antelope Creek
OSN2073	2008	154	104	Mule Creek, Antelope Creek
OSN2074	2008	154	104	Mule Creek, North Sawmill Creek
OSN2075	2008	154	104	Mule Creek, Antelope Creek
OSN2076	2008	154	104	Mule Creek, North Sawmill Creek
OSN2077	2008	154	104	Mule Creek, Antelope Creek
OSN2078	2008	154	104	Mule Creek, Antelope Creek
OSN2079	2008	154	104	Mule Creek, Antelope Creek
OSN2080	2008	154	104	Mule Creek, North Sawmill Creek
OSN2081	2008	154	104	Mule Creek, North Sawmill Creek
OSN2082	2008	154	104	Mule Creek, North Sawmill Creek
OSN2083	2008	154	104	Mule Creek, North Sawmill Creek
OSN2084	2008	154	104	Mule Creek, North Sawmill Creek
OSN2085	2008	154	104	Mule Creek, North Sawmill Creek
OSN2086	2008	154	104	Mule Creek, North Sawmill Creek
OSN2087	2008	154	104	Mule Creek, Antelope Creek
OSN2088	2008	154	104	Mule Creek, Antelope Creek
OSN2089	2008	154	104	Mule Creek, Antelope Creek
OSN2090	2008	159	106	Mule Creek, Antelope Creek
OSN2091	2008	159	106	Mule Creek, Antelope Creek
OSN2092	2008	159	106	Mule Creek, North Sawmill Creek
OSN2093	2008	159	106	Mule Creek, Antelope Creek
OSN2094	2008	159	106	Mule Creek, North Sawmill Creek
OSN2095	2008	159	106	Mule Creek, Antelope Creek
OSN2096	2008	159	106	Mule Creek, Antelope Creek
OSN2097	2008	159	106	Mule Creek, Antelope Creek
OSN2098	2008	159	106	Mule Creek, Antelope Creek
OSN2099	2008	159	106	Mule Creek, Antelope Creek
OSN2100	2008	159	106	Mule Creek, Antelope Creek
OSN2101	2008	159	106	Mule Creek, North Sawmill Creek
OSN2102	2008	159	106	Mule Creek, North Sawmill Creek
OSN2103	2008	159	106	Mule Creek, North Sawmill Creek
OSN2104	2008	159	106	Mule Creek, Antelope Creek
OSN2105	2008	159	106	Unknown 1

Table A.3. Continued.

Lab Observation No.	Field Season	Field No.	Unit No.	Source
OSN2106	2008	159	106	Mule Creek, North Sawmill Creek
OSN2107	2008	159	106	Mule Creek, Antelope Creek
OSN2108	2008	159	106	Mule Creek, Antelope Creek
OSN2109	2008	159	106	Mule Creek, Antelope Creek
OSN2110	2008	159	106	Mule Creek, Antelope Creek
OSN2111	2008	162	106	Mule Creek, Antelope Creek
OSN2112	2008	162	106	Mule Creek, Antelope Creek
OSN2113	2008	162	106	Mule Creek, Antelope Creek
OSN2114	2008	162	106	Mule Creek, Antelope Creek
OSN2115	2008	162	106	Mule Creek, Antelope Creek
OSN2116	2008	162	106	Mule Creek, Antelope Creek
OSN2117	2008	162	106	Mule Creek, Antelope Creek
OSN2118	2008	162	106	Mule Creek, Antelope Creek
OSN2119	2008	162	106	Mule Creek, North Sawmill Creek
OSN2120	2008	162	106	Mule Creek, Antelope Creek
OSN2121	2008	162	106	Mule Creek, Antelope Creek
OSN2122	2008	162	106	Mule Creek, Antelope Creek
OSN2123	2008	162	106	Mule Creek, Antelope Creek
OSN2124	2008	162	106	Mule Creek, Antelope Creek
OSN2125	2008	162	106	Mule Creek, Antelope Creek
OSN2126	2008	162	106	Mule Creek, North Sawmill Creek
OSN2127	2008	162	106	Mule Creek, Antelope Creek
OSN2128	2008	162	106	Mule Creek, Antelope Creek
OSN2129	2008	162	106	Unknown 1
OSN2130	2008	162	106	Mule Creek, North Sawmill Creek
OSN2131	2008	162	106	Mule Creek, Antelope Creek
OSN2132	2008	162	106	Mule Creek, Antelope Creek
OSN2133	2008	162	106	Mule Creek, Antelope Creek
OSN2134	2008	162	106	Mule Creek, Antelope Creek
OSN2135	2008	165	106	Mule Creek, Mule Mountains
OSN2136	2008	165	106	Mule Creek, Antelope Creek
OSN2137	2008	165	106	Mule Creek, Antelope Creek
OSN2138	2008	165	106	Mule Creek, Antelope Creek
OSN2139	2008	165	106	Mule Creek, Antelope Creek
OSN2140	2008	165	106	Mule Creek, Antelope Creek
OSN2141	2008	165	106	Mule Creek, Antelope Creek
OSN2142	2008	165	106	Mule Creek, Antelope Creek
OSN2143	2008	165	106	Mule Creek, Antelope Creek
OSN2144	2008	165	106	Mule Creek, Antelope Creek
OSN2145	2008	165	106	Mule Creek, North Sawmill Creek
OSN2146	2008	165	106	Mule Creek, North Sawmill Creek
OSN2147	2008	165	106	Mule Creek, Antelope Creek
OSN2148	2008	165	106	Mule Creek, Antelope Creek
OSN2149	2008	165	106	Mule Creek, Antelope Creek
OSN2150	2008	165	106	Mule Creek, North Sawmill Creek
OSN2151	2008	165	106	Mule Creek, Antelope Creek
OSN2152	2008	165	106	Mule Creek, Antelope Creek
OSN2153	2008	165	106	Mule Creek, Antelope Creek
OSN2154	2008	167	105	Mule Creek, Antelope Creek
OSN2155	2008	167	105	Mule Creek, Antelope Creek
OSN2156	2008	167	105	Mule Creek, Antelope Creek
OSN2157	2008	167	105	Mule Creek, Antelope Creek

Table A.3. Continued.

Lab Observation No.	Field Season	Field No.	Unit No.	Source
OSN2158	2008	167	105	Mule Creek, Antelope Creek
OSN2159	2008	167	105	Mule Creek, Antelope Creek
OSN2160	2008	167	105	Mule Creek, Antelope Creek
OSN2161	2008	167	105	Mule Creek, Antelope Creek
OSN2162	2008	167	105	Mule Creek, Antelope Creek
OSN2163	2008	167	105	Mule Creek, Antelope Creek
OSN2164	2008	167	105	Mule Creek, Antelope Creek
OSN2165	2008	167	105	Mule Creek, Antelope Creek
OSN2166	2008	167	105	Mule Creek, Antelope Creek
OSN2167	2008	167	105	Mule Creek, North Sawmill Creek
OSN2168	2008	167	105	Mule Creek, Antelope Creek
OSN2169	2008	167	105	Mule Creek, Antelope Creek
OSN2170	2008	167	105	Mule Creek, Antelope Creek
OSN2171	2008	167	105	Not obsidian
OSN2172	2008	167	105	Mule Creek, Antelope Creek
OSN2173	2008	167	105	Mule Creek, Antelope Creek
OSN2174	2008	167	105	Mule Creek, Antelope Creek
OSN2175	2008	167	105	Mule Creek, Antelope Creek
OSN2176	2008	167	105	Mule Creek, Antelope Creek
OSN2177	2008	167	105	Mule Creek, North Sawmill Creek
OSN2178	2008	167	105	Mule Creek, Antelope Creek
OSN2179	2008	175	105	Mule Creek, North Sawmill Creek
OSN2180	2008	175	105	Mule Creek, Antelope Creek
OSN2181	2008	175	105	Mule Creek, North Sawmill Creek
OSN2182	2008	175	105	Mule Creek, Antelope Creek
OSN2183	2008	175	105	Mule Creek, Antelope Creek
OSN2184	2008	175	105	Mule Creek, North Sawmill Creek
OSN2185	2008	175	105	Mule Creek, Antelope Creek
OSN2186	2008	175	105	Mule Creek, Antelope Creek
OSN2187	2008	175	105	Mule Creek, Antelope Creek
OSN2188	2008	175	105	Mule Creek, Antelope Creek
OSN2189	2008	182	105	Mule Creek, North Sawmill Creek
OSN2190	2008	182	105	Mule Creek, Antelope Creek
OSN2191	2008	182	105	Mule Creek, Antelope Creek
OSN2192	2008	182	105	Mule Creek, North Sawmill Creek
OSN2193	2008	182	105	Mule Creek, Antelope Creek
OSN2194	2008	182	105	Mule Creek, Antelope Creek
OSN2195	2008	184	104	Mule Creek, North Sawmill Creek
OSN2196	2008	184	104	Mule Creek, North Sawmill Creek
OSN2197	2008	184	104	Mule Creek, Antelope Creek
OSN2198	2008	197	104	Mule Creek, North Sawmill Creek
OSN2199	2008	197	104	Mule Creek, North Sawmill Creek
OSN2200	2008	197	104	Mule Creek, North Sawmill Creek
OSN2201	2008	197	104	Mule Creek, Antelope Creek
OSN2202	2008	197	104	Mule Creek, North Sawmill Creek
OSN2203	2008	197	104	Mule Creek, Antelope Creek
OSN2204	2008	197	104	Mule Creek, North Sawmill Creek
OSN2205	2008	197	104	Mule Creek, Antelope Creek
OSN2206	2008	197	104	Mule Creek, Antelope Creek
OSN2207	2008	197	104	Mule Creek, Antelope Creek
OSN2208	2008	197	104	Mule Creek, North Sawmill Creek
OSN2209	2008	197	104	Mule Creek, Antelope Creek

Table A.3. Continued.

Lab Observation No.	Field Season	Field No.	Unit No.	Source
OSN2210	2008	197	104	Mule Creek, Antelope Creek
OSN2211	2008	197	104	Mule Creek, Antelope Creek
OSN2212	2008	197	104	Mule Creek, Antelope Creek
OSN2213	2008	197	104	Mule Creek, Antelope Creek
OSN2214	2008	197	104	Mule Creek, Antelope Creek
OSN2215	2008	197	104	Mule Creek, North Sawmill Creek
OSN2216	2008	197	104	Mule Creek, North Sawmill Creek
OSN2217	2008	197	104	Mule Creek, Antelope Creek
OSN2218	2008	197	104	Mule Creek, North Sawmill Creek
OSN2219	2008	197	104	Mule Creek, Antelope Creek
OSN2220	2008	197	104	Mule Creek, Antelope Creek
OSN2221	2009	198	301	Mule Creek, North Sawmill Creek
OSN2222	2009	198	301	Mule Creek, Antelope Creek
OSN2223	2009	198	301	Mule Creek, Antelope Creek
OSN2224	2009	198	301	Mule Creek, Antelope Creek
OSN2225	2009	198	301	Mule Creek, Antelope Creek
OSN2226	2009	198	301	Mule Creek, North Sawmill Creek
OSN2227	2009	198	301	Unassigned (too small)
OSN2228	2009	198	301	Mule Creek, North Sawmill Creek
OSN2229	2009	198	301	Mule Creek, Antelope Creek
OSN2230	2009	198	301	Mule Creek, North Sawmill Creek
OSN2231	2009	198	301	Unassigned (too small)
OSN2232	2009	198	301	Mule Creek, Antelope Creek
OSN2233	2008	204	107	Mule Creek, Antelope Creek
OSN2234	2008	204	107	Mule Creek, Antelope Creek
OSN2235	2008	204	107	Mule Creek, North Sawmill Creek
OSN2236	2008	204	107	Mule Creek, Antelope Creek
OSN2237	2008	204	107	Mule Creek, Antelope Creek
OSN2238	2008	204	107	Mule Creek, Antelope Creek
OSN2239	2008	204	107	Mule Creek, North Sawmill Creek
OSN2240	2008	204	107	Mule Creek, North Sawmill Creek
OSN2241	2008	204	107	Mule Creek, North Sawmill Creek
OSN2242	2008	204	107	Mule Creek, Antelope Creek
OSN2243	2008	204	107	Mule Creek, Antelope Creek
OSN2244	2008	204	107	Mule Creek, Antelope Creek
OSN2245	2008	204	107	Mule Creek, Antelope Creek
OSN2246	2008	204	107	Mule Creek, Antelope Creek
OSN2247	2008	204	107	Mule Creek, Antelope Creek
OSN2248	2008	204	107	Mule Creek, Antelope Creek
OSN2249	2008	204	107	Mule Creek, Antelope Creek
OSN2250	2008	204	107	Mule Creek, Antelope Creek
OSN2251	2008	204	107	Mule Creek, Antelope Creek
OSN2252	2008	204	107	Mule Creek, North Sawmill Creek
OSN2253	2008	204	107	Mule Creek, Antelope Creek
OSN2254	2008	204	107	Mule Creek, Antelope Creek
OSN2255	2008	204	107	Mule Creek, Antelope Creek
OSN2256	2008	204	107	Mule Creek, North Sawmill Creek
OSN2257	2008	204	107	Mule Creek, Antelope Creek
OSN2258	2008	207	107	Mule Creek, North Sawmill Creek
OSN2259	2008	207	107	Mule Creek, Antelope Creek
OSN2260	2008	207	107	Mule Creek, Antelope Creek
OSN2261	2008	207	107	Mule Creek, Antelope Creek

Table A.3. Continued.

Lab Observation No.	Field Season	Field No.	Unit No.	Source
OSN2262	2008	207	107	Mule Creek, Antelope Creek
OSN2263	2008	207	107	Mule Creek, Antelope Creek
OSN2264	2008	207	107	Mule Creek, Antelope Creek
OSN2265	2008	207	107	Mule Creek, Antelope Creek
OSN2266	2008	207	107	Mule Creek, Antelope Creek
OSN2267	2008	207	107	Mule Creek, North Sawmill Creek
OSN2268	2008	207	107	Mule Creek, Antelope Creek
OSN2269	2008	207	107	Mule Creek, Antelope Creek
OSN2270	2008	207	107	Mule Creek, Antelope Creek
OSN2271	2008	207	107	Mule Creek, Antelope Creek
OSN2272	2008	207	107	Mule Creek, Antelope Creek
OSN2273	2008	207	107	Mule Creek, North Sawmill Creek
OSN2274	2008	207	107	Mule Creek, North Sawmill Creek
OSN2275	2008	207	107	Mule Creek, Antelope Creek
OSN2276	2008	207	107	Not obsidian
OSN2277	2008	207	107	Mule Creek, North Sawmill Creek
OSN2278	2008	207	107	Mule Creek, North Sawmill Creek
OSN2279	2008	207	107	Mule Creek, North Sawmill Creek
OSN2280	2008	207	107	Mule Creek, Antelope Creek
OSN2281	2008	207	107	Mule Creek, North Sawmill Creek
OSN2282	2009	213	301	Mule Creek, Antelope Creek
OSN2283	2009	213	301	Mule Creek, North Sawmill Creek
OSN2284	2009	213	301	Mule Creek, Antelope Creek
OSN2285	2009	213	301	Mule Creek, Antelope Creek
OSN2286	2009	213	301	Mule Creek, North Sawmill Creek
OSN2287	2009	213	301	Mule Creek, North Sawmill Creek
OSN2288	2009	213	301	Mule Creek, Antelope Creek
OSN2289	2009	213	301	Mule Creek, Antelope Creek
OSN2290	2009	213	301	Mule Creek, Antelope Creek
OSN2291	2009	213	301	Mule Creek, Antelope Creek
OSN2292	2009	213	301	Mule Creek, Antelope Creek
OSN2293	2009	213	301	Mule Creek, Antelope Creek
OSN2294	2009	213	301	Mule Creek, Antelope Creek
OSN2295	2009	213	301	Mule Creek, Antelope Creek
OSN2296	2009	213	301	Mule Creek, Antelope Creek
OSN2297	2009	213	301	Mule Creek, Antelope Creek
OSN2298	2009	213	301	Mule Creek, Antelope Creek
OSN2299	2009	213	301	Mule Creek, Antelope Creek
OSN2300	2009	213	301	Mule Creek, Antelope Creek
OSN2301	2009	213	301	Mule Creek, Antelope Creek
OSN2302	2009	213	301	Mule Creek, North Sawmill Creek
OSN2303	2009	213	301	Mule Creek, Antelope Creek
OSN2304	2009	213	301	Mule Creek, Antelope Creek
OSN2305	2009	213	301	Mule Creek, Antelope Creek
OSN2306	2009	213	301	Mule Creek, North Sawmill Creek
OSN2307	2008	215	104	Mule Creek, Antelope Creek
OSN2308	2008	215	104	Mule Creek, Antelope Creek
OSN2309	2008	215	104	Mule Creek, North Sawmill Creek
OSN2310	2008	215	104	Mule Creek, Antelope Creek
OSN2311	2009	216	301	Mule Creek, Antelope Creek
OSN2312	2009	216	301	Mule Creek, Antelope Creek
OSN2313	2009	216	301	Mule Creek, Antelope Creek

Table A.3. Continued.

Lab Observation No.	Field Season	Field No.	Unit No.	Source
OSN2314	2009	216	301	Mule Creek, Antelope Creek
OSN2315	2009	216	301	Unknown 1
OSN2316	2009	216	301	Mule Creek, Antelope Creek
OSN2317	2009	216	301	Mule Creek, North Sawmill Creek
OSN2318	2009	216	301	Mule Creek, Antelope Creek
OSN2319	2009	216	301	Mule Creek, North Sawmill Creek
OSN2320	2009	216	301	Mule Creek, Antelope Creek
OSN2321	2009	216	301	Mule Creek, Antelope Creek
OSN2322	2009	216	301	Mule Creek, Antelope Creek
OSN2323	2009	216	301	Mule Creek, Antelope Creek
OSN2324	2009	216	301	Mule Creek, Antelope Creek
OSN2325	2009	216	301	Mule Creek, North Sawmill Creek
OSN2326	2009	216	301	Mule Creek, North Sawmill Creek
OSN2327	2009	216	301	Mule Creek, Antelope Creek
OSN2328	2009	216	301	Mule Creek, Antelope Creek
OSN2329	2009	216	301	Mule Creek, Antelope Creek
OSN2330	2009	216	301	Mule Creek, Antelope Creek
OSN2331	2009	216	301	Mule Creek, Antelope Creek
OSN2332	2009	216	301	Mule Creek, North Sawmill Creek
OSN2333	2009	216	301	Mule Creek, Antelope Creek
OSN2334	2009	216	301	Mule Creek, North Sawmill Creek
OSN2335	2009	216	301	Mule Creek, North Sawmill Creek
OSN2336	2008	220	107	Mule Creek, Antelope Creek
OSN2337	2008	220	107	Mule Creek, Antelope Creek
OSN2338	2008	220	107	Mule Creek, Antelope Creek
OSN2339	2008	220	107	Mule Creek, Antelope Creek
OSN2340	2008	220	107	Mule Creek, Antelope Creek
OSN2341	2008	220	107	Mule Creek, Antelope Creek
OSN2342	2008	220	107	Mule Creek, Antelope Creek
OSN2343	2008	220	107	Mule Creek, North Sawmill Creek
OSN2344	2008	220	107	Mule Creek, Antelope Creek
OSN2345	2008	220	107	Mule Creek, Antelope Creek
OSN2346	2008	220	107	Mule Creek, Antelope Creek
OSN2347	2008	220	107	Mule Creek, North Sawmill Creek
OSN2348	2008	220	107	Mule Creek, Antelope Creek
OSN2349	2008	220	107	Mule Creek, North Sawmill Creek
OSN2350	2008	220	107	Mule Creek, Antelope Creek
OSN2351	2008	220	107	Mule Creek, North Sawmill Creek
OSN2352	2008	220	107	Mule Creek, Antelope Creek
OSN2353	2008	220	107	Mule Creek, Antelope Creek
OSN2354	2008	220	107	Mule Creek, Antelope Creek
OSN2355	2008	220	107	Mule Creek, North Sawmill Creek
OSN2356	2008	220	107	Mule Creek, Antelope Creek
OSN2357	2008	220	107	Mule Creek, Antelope Creek
OSN2358	2008	220	107	Mule Creek, Antelope Creek
OSN2359	2008	220	107	Mule Creek, Antelope Creek
OSN2360	2008	220	107	Mule Creek, Antelope Creek
OSN2361	2008	220	107	Mule Creek, Antelope Creek
OSN2362	2009	220	301	Mule Creek, North Sawmill Creek
OSN2363	2009	220	301	Mule Creek, Antelope Creek
OSN2364	2009	220	301	Mule Creek, Antelope Creek
OSN2365	2009	220	301	Mule Creek, Antelope Creek

Table A.3. Continued.

Lab Observation No.	Field Season	Field No.	Unit No.	Source
OSN2366	2009	220	301	Mule Creek, North Sawmill Creek
OSN2367	2009	220	301	Mule Creek, Antelope Creek
OSN2368	2009	220	301	Mule Creek, North Sawmill Creek
OSN2369	2009	220	301	Mule Creek, Antelope Creek
OSN2370	2009	220	301	Mule Creek, Antelope Creek
OSN2371	2009	220	301	Mule Creek, Antelope Creek
OSN2372	2009	220	301	Mule Creek, Antelope Creek
OSN2373	2009	220	301	Mule Creek, North Sawmill Creek
OSN2374	2009	220	301	Mule Creek, Antelope Creek
OSN2375	2009	220	301	Mule Creek, North Sawmill Creek
OSN2376	2009	220	301	Mule Creek, Antelope Creek
OSN2377	2009	220	301	Mule Creek, North Sawmill Creek
OSN2378	2009	220	301	Unassigned
OSN2379	2009	220	301	Mule Creek, North Sawmill Creek
OSN2380	2009	220	301	Mule Creek, Antelope Creek
OSN2381	2009	220	301	Mule Creek, Antelope Creek
OSN2382	2009	220	301	Mule Creek, Antelope Creek
OSN2383	2009	220	301	Mule Creek, North Sawmill Creek
OSN2384	2009	220	301	Mule Creek, Antelope Creek
OSN2385	2009	220	301	Mule Creek, Antelope Creek
OSN2386	2009	220	301	Mule Creek, North Sawmill Creek
OSN2387	2008	224	106	Mule Creek, Antelope Creek
OSN2388	2008	224	106	Mule Creek, Antelope Creek
OSN2389	2008	224	106	Mule Creek, North Sawmill Creek
OSN2390	2008	224	106	Mule Creek, Antelope Creek
OSN2391	2008	224	106	Mule Creek, Antelope Creek
OSN2392	2008	224	106	Mule Creek, Antelope Creek
OSN2393	2008	224	106	Mule Creek, Antelope Creek
OSN2394	2008	224	106	Mule Creek, Antelope Creek
OSN2395	2008	224	106	Mule Creek, Antelope Creek
OSN2396	2008	224	106	Mule Creek, North Sawmill Creek
OSN2397	2008	224	106	Mule Creek, Antelope Creek
OSN2398	2008	224	106	Mule Creek, Antelope Creek
OSN2399	2008	224	106	Mule Creek, North Sawmill Creek
OSN2400	2008	224	106	Mule Creek, North Sawmill Creek
OSN2401	2008	224	106	Mule Creek, Antelope Creek
OSN2402	2008	224	106	Mule Creek, Antelope Creek
OSN2403	2008	224	106	Mule Creek, Antelope Creek
OSN2404	2008	224	106	Mule Creek, Antelope Creek
OSN2405	2008	224	106	Mule Creek, North Sawmill Creek
OSN2406	2008	224	106	Mule Creek, Antelope Creek
OSN2407	2008	224	106	Mule Creek, Mule Mountains
OSN2408	2008	224	106	Mule Creek, Antelope Creek
OSN2409	2008	224	106	Mule Creek, Antelope Creek
OSN2410	2008	224	106	Mule Creek, Antelope Creek
OSN2411	2008	224	106	Mule Creek, Antelope Creek
OSN2412	2009	225	301	Mule Creek, Antelope Creek
OSN2413	2009	225	301	Mule Creek, Antelope Creek
OSN2414	2009	225	301	Mule Creek, North Sawmill Creek
OSN2415	2009	225	301	Mule Creek, Antelope Creek
OSN2416	2009	225	301	Mule Creek, Antelope Creek
OSN2417	2009	225	301	Mule Creek, North Sawmill Creek

Table A.3. Continued.

Lab Observation No.	Field Season	Field No.	Unit No.	Source
OSN2418	2009	225	301	Mule Creek, Antelope Creek
OSN2419	2009	225	301	Mule Creek, North Sawmill Creek
OSN2420	2009	225	301	Mule Creek, Antelope Creek
OSN2421	2009	225	301	Mule Creek, Antelope Creek
OSN2422	2009	225	301	Mule Creek, Antelope Creek
OSN2423	2009	225	301	Mule Creek, North Sawmill Creek
OSN2424	2009	225	301	Mule Creek, Antelope Creek
OSN2425	2009	225	301	Mule Creek, North Sawmill Creek
OSN2426	2009	225	301	Mule Creek, North Sawmill Creek
OSN2427	2009	225	301	Mule Creek, Antelope Creek
OSN2428	2009	225	301	Mule Creek, Antelope Creek
OSN2429	2009	225	301	Mule Creek, Antelope Creek
OSN2430	2009	225	301	Mule Creek, North Sawmill Creek
OSN2431	2009	225	301	Mule Creek, Antelope Creek
OSN2432	2009	225	301	Mule Creek, North Sawmill Creek
OSN2433	2009	225	301	Mule Creek, Antelope Creek
OSN2434	2009	225	301	Mule Creek, Antelope Creek
OSN2435	2009	225	301	Mule Creek, Antelope Creek
OSN2436	2009	225	301	Mule Creek, Antelope Creek
OSN2437	2008	228	108	Mule Creek, Antelope Creek
OSN2438	2008	228	108	Mule Creek, Antelope Creek
OSN2439	2008	228	108	Mule Creek, Antelope Creek
OSN2440	2008	228	108	Mule Creek, North Sawmill Creek
OSN2441	2008	228	108	Mule Creek, Antelope Creek
OSN2442	2008	228	108	Mule Creek, Antelope Creek
OSN2443	2008	228	108	Mule Creek, Antelope Creek
OSN2444	2008	228	108	Mule Creek, Antelope Creek
OSN2445	2008	228	108	Mule Creek, Antelope Creek
OSN2446	2008	228	108	Mule Creek, North Sawmill Creek
OSN2447	2008	228	108	Mule Creek, North Sawmill Creek
OSN2448	2008	228	108	Mule Creek, North Sawmill Creek
OSN2449	2008	228	108	Mule Creek, North Sawmill Creek
OSN2450	2008	228	108	Mule Creek, Antelope Creek
OSN2451	2008	228	108	Mule Creek, North Sawmill Creek
OSN2452	2008	228	108	Mule Creek, Antelope Creek
OSN2453	2008	228	108	Mule Creek, Antelope Creek
OSN2454	2008	228	108	Mule Creek, Antelope Creek
OSN2455	2008	228	108	Mule Creek, Antelope Creek
OSN2456	2008	228	108	Mule Creek, Antelope Creek
OSN2457	2008	228	108	Mule Creek, Antelope Creek
OSN2458	2008	228	108	Mule Creek, North Sawmill Creek
OSN2459	2008	228	108	Mule Creek, Antelope Creek
OSN2460	2008	228	108	Mule Creek, Antelope Creek
OSN2461	2008	228	108	Mule Creek, Antelope Creek
OSN2462	2008	231	107	Mule Creek, North Sawmill Creek
OSN2463	2008	231	107	Mule Creek, Antelope Creek
OSN2464	2008	231	107	Mule Creek, Antelope Creek
OSN2465	2008	231	107	Mule Creek, North Sawmill Creek
OSN2466	2008	231	107	Mule Creek, Antelope Creek
OSN2467	2008	231	107	Mule Creek, North Sawmill Creek
OSN2468	2008	233	108	Mule Creek, Antelope Creek
OSN2469	2008	233	108	Mule Creek, Antelope Creek

Table A.3. Continued.

Lab Observation No.	Field Season	Field No.	Unit No.	Source
OSN2470	2008	233	108	Mule Creek, Antelope Creek
OSN2471	2008	233	108	Mule Creek, Antelope Creek
OSN2472	2008	233	108	Mule Creek, Antelope Creek
OSN2473	2008	233	108	Mule Creek, North Sawmill Creek
OSN2474	2008	233	108	Mule Creek, Antelope Creek
OSN2475	2008	233	108	Mule Creek, North Sawmill Creek
OSN2476	2008	233	108	Mule Creek, Antelope Creek
OSN2477	2008	233	108	Mule Creek, Antelope Creek
OSN2478	2008	233	108	Mule Creek, Antelope Creek
OSN2479	2008	233	108	Mule Creek, Antelope Creek
OSN2480	2008	233	108	Mule Creek, Antelope Creek
OSN2481	2008	233	108	Mule Creek, Antelope Creek
OSN2482	2008	233	108	Mule Creek, Antelope Creek
OSN2483	2008	233	108	Mule Creek, Antelope Creek
OSN2484	2008	233	108	Mule Creek, North Sawmill Creek
OSN2485	2008	233	108	Mule Creek, North Sawmill Creek
OSN2486	2008	233	108	Mule Creek, Antelope Creek
OSN2487	2008	233	108	Mule Creek, North Sawmill Creek
OSN2488	2008	233	108	Mule Creek, Antelope Creek
OSN2489	2008	233	108	Mule Creek, Antelope Creek
OSN2490	2008	233	108	Mule Creek, Antelope Creek
OSN2491	2008	233	108	Mule Creek, Antelope Creek
OSN2492	2008	233	108	Mule Creek, Antelope Creek
OSN2493	2009	233	301	Mule Creek, North Sawmill Creek
OSN2494	2009	233	301	Mule Creek, Antelope Creek
OSN2495	2009	233	301	Mule Creek, Antelope Creek
OSN2496	2009	233	301	Mule Creek, North Sawmill Creek
OSN2497	2009	233	301	Mule Creek, North Sawmill Creek
OSN2498	2009	233	301	Mule Creek, North Sawmill Creek
OSN2499	2009	233	301	Mule Creek, Antelope Creek
OSN2500	2009	233	301	Mule Creek, Antelope Creek
OSN2501	2009	233	301	Mule Creek, Antelope Creek
OSN2502	2009	233	301	Mule Creek, Antelope Creek
OSN2503	2009	233	301	Mule Creek, Antelope Creek
OSN2504	2009	233	301	Mule Creek, Antelope Creek
OSN2505	2009	233	301	Mule Creek, Antelope Creek
OSN2506	2009	233	301	Mule Creek, Antelope Creek
OSN2507	2009	233	301	Mule Creek, Antelope Creek
OSN2508	2009	233	301	Mule Creek, Antelope Creek
OSN2509	2009	233	301	Mule Creek, Antelope Creek
OSN2510	2009	233	301	Mule Creek, Antelope Creek
OSN2511	2009	233	301	Mule Creek, North Sawmill Creek
OSN2512	2009	233	301	Mule Creek, North Sawmill Creek
OSN2513	2009	233	301	Mule Creek, Antelope Creek
OSN2514	2009	233	301	Mule Creek, Antelope Creek
OSN2515	2009	233	301	Mule Creek, Antelope Creek
OSN2516	2009	233	301	Mule Creek, North Sawmill Creek
OSN2517	2009	233	301	Mule Creek, North Sawmill Creek
OSN2518	2008	237	108	Mule Creek, Antelope Creek
OSN2519	2008	237	108	Mule Creek, Antelope Creek
OSN2520	2008	237	108	Mule Creek, Antelope Creek
OSN2521	2008	237	108	Mule Creek, Antelope Creek

Table A.3. Continued.

Lab Observation No.	Field Season	Field No.	Unit No.	Source
OSN2522	2008	237	108	Mule Creek, Antelope Creek
OSN2523	2008	237	108	Mule Creek, Antelope Creek
OSN2524	2008	237	108	Mule Creek, Antelope Creek
OSN2525	2008	237	108	Mule Creek, Mule Mountains
OSN2526	2008	237	108	Mule Creek, Antelope Creek
OSN2527	2008	237	108	Mule Creek, Antelope Creek
OSN2528	2008	237	108	Mule Creek, Antelope Creek
OSN2529	2008	237	108	Mule Creek, Antelope Creek
OSN2530	2008	237	108	Mule Creek, Antelope Creek
OSN2531	2008	242	103	Mule Creek, Antelope Creek
OSN2532	2008	242	103	Mule Creek, North Sawmill Creek
OSN2533	2008	242	103	Mule Creek, Antelope Creek
OSN2534	2008	242	103	Mule Creek, Antelope Creek
OSN2535	2008	242	103	Mule Creek, North Sawmill Creek
OSN2536	2008	242	103	Mule Creek, North Sawmill Creek
OSN2537	2008	242	103	Mule Creek, Antelope Creek
OSN2538	2008	242	103	Mule Creek, Antelope Creek
OSN2539	2008	242	103	Mule Creek, Antelope Creek
OSN2540	2008	242	103	Mule Creek, Antelope Creek
OSN2541	2008	242	103	Mule Creek, Antelope Creek
OSN2542	2008	242	103	Mule Creek, Antelope Creek
OSN2543	2008	242	103	Mule Creek, Antelope Creek
OSN2544	2008	242	103	Mule Creek, Antelope Creek
OSN2545	2008	242	103	Mule Creek, Antelope Creek
OSN2546	2008	242	103	Mule Creek, Antelope Creek
OSN2547	2008	242	103	Mule Creek, Antelope Creek
OSN2548	2008	242	103	Mule Creek, Antelope Creek
OSN2549	2008	242	103	Mule Creek, Antelope Creek
OSN2550	2008	242	103	Mule Creek, Antelope Creek
OSN2551	2008	242	103	Mule Creek, Antelope Creek
OSN2552	2008	242	103	Mule Creek, Antelope Creek
OSN2553	2008	242	103	Mule Creek, Antelope Creek
OSN2554	2008	242	103	Mule Creek, North Sawmill Creek
OSN2555	2008	242	103	Mule Creek, North Sawmill Creek
OSN2556	2008	242	103	Mule Creek, Antelope Creek
OSN2557	2008	246	103	Mule Creek, Antelope Creek
OSN2558	2008	246	103	Mule Creek, Antelope Creek
OSN2559	2008	246	103	Mule Creek, Antelope Creek
OSN2560	2008	246	103	Mule Creek, Antelope Creek
OSN2561	2008	246	103	Mule Creek, Antelope Creek
OSN2562	2008	246	103	Mule Creek, Antelope Creek
OSN2563	2008	246	103	Mule Creek, Antelope Creek
OSN2564	2008	246	103	Mule Creek, North Sawmill Creek
OSN2565	2008	246	103	Mule Creek, Antelope Creek
OSN2566	2008	246	103	Mule Creek, Antelope Creek
OSN2567	2008	246	103	Mule Creek, Antelope Creek
OSN2568	2008	246	103	Mule Creek, Antelope Creek
OSN2569	2008	246	103	Mule Creek, Antelope Creek
OSN2570	2008	246	103	Mule Creek, Antelope Creek
OSN2571	2008	246	103	Mule Creek, Antelope Creek
OSN2572	2008	246	103	Mule Creek, North Sawmill Creek
OSN2573	2008	246	103	Mule Creek, Antelope Creek

Table A.3. Continued.

Lab Observation No.	Field Season	Field No.	Unit No.	Source
OSN2574	2008	246	103	Mule Creek, Antelope Creek
OSN2575	2008	246	103	Mule Creek, Antelope Creek
OSN2576	2008	246	103	Mule Creek, North Sawmill Creek
OSN2577	2008	246	103	Mule Creek, Antelope Creek
OSN2578	2008	246	103	Mule Creek, Antelope Creek
OSN2579	2008	246	103	Mule Creek, Antelope Creek
OSN2580	2008	246	103	Mule Creek, North Sawmill Creek
OSN2581	2008	246	103	Mule Creek, North Sawmill Creek
OSN2582	2008	251	106	Mule Creek, Antelope Creek
OSN2583	2008	251	106	Mule Creek, Antelope Creek
OSN2584	2008	251	106	Mule Creek, Antelope Creek
OSN2585	2008	251	106	Mule Creek, Antelope Creek
OSN2586	2008	251	106	Mule Creek, Antelope Creek
OSN2587	2008	251	106	Mule Creek, North Sawmill Creek
OSN2588	2008	251	106	Mule Creek, Antelope Creek
OSN2589	2008	251	106	Mule Creek, Antelope Creek
OSN2590	2008	251	106	Mule Creek, Antelope Creek
OSN2591	2008	251	106	Mule Creek, Antelope Creek
OSN2592	2008	251	106	Mule Creek, Antelope Creek
OSN2593	2008	251	106	Mule Creek, Antelope Creek
OSN2594	2008	251	106	Mule Creek, Antelope Creek
OSN2595	2008	261	103	Mule Creek, Antelope Creek
OSN2596	2008	261	103	Mule Creek, North Sawmill Creek
OSN2597	2008	261	103	Mule Creek, Antelope Creek
OSN2598	2008	261	103	Mule Creek, Antelope Creek
OSN2599	2008	261	103	Mule Creek, Antelope Creek
OSN2600	2008	261	103	Mule Creek, North Sawmill Creek
OSN2601	2008	261	103	Mule Creek, Antelope Creek
OSN2602	2008	261	103	Cow Canyon
OSN2603	2008	261	103	Mule Creek, Antelope Creek
OSN2604	2008	261	103	Mule Creek, North Sawmill Creek
OSN2605	2008	261	103	Mule Creek, North Sawmill Creek
OSN2606	2008	261	103	Mule Creek, Antelope Creek
OSN2607	2008	261	103	Mule Creek, Antelope Creek
OSN2608	2008	261	103	Mule Creek, Antelope Creek
OSN2609	2008	261	103	Mule Creek, Antelope Creek
OSN2610	2008	261	103	Mule Creek, Antelope Creek
OSN2611	2008	261	103	Mule Creek, Antelope Creek
OSN2612	2008	261	103	Mule Creek, Antelope Creek
OSN2613	2008	261	103	Mule Creek, Antelope Creek
OSN2614	2008	261	103	Mule Creek, Antelope Creek
OSN2615	2008	261	103	Mule Creek, Antelope Creek
OSN2616	2008	261	103	Mule Creek, North Sawmill Creek
OSN2617	2008	261	103	Mule Creek, Antelope Creek
OSN2618	2008	261	103	Mule Creek, Antelope Creek
OSN2619	2008	261	103	Mule Creek, Antelope Creek
OSN2620	2008	269	103	Mule Creek, Antelope Creek
OSN2621	2008	269	103	Mule Creek, Antelope Creek
OSN2622	2008	269	103	Mule Creek, Antelope Creek
OSN2623	2008	269	103	Mule Creek, Antelope Creek
OSN2624	2008	269	103	Mule Creek, Antelope Creek
OSN2625	2008	269	103	Mule Creek, Antelope Creek

Table A.3. Continued.

Lab Observation No.	Field Season	Field No.	Unit No.	Source
OSN2626	2008	269	103	Mule Creek, Antelope Creek
OSN2627	2008	269	103	Mule Creek, Antelope Creek
OSN2628	2008	269	103	Mule Creek, Antelope Creek
OSN2629	2008	269	103	Mule Creek, Antelope Creek
OSN2630	2008	269	103	Mule Creek, Antelope Creek
OSN2631	2008	269	103	Mule Creek, North Sawmill Creek
OSN2632	2008	269	103	Mule Creek, Antelope Creek
OSN2633	2008	269	103	Mule Creek, Antelope Creek
OSN2634	2008	269	103	Mule Creek, Antelope Creek
OSN2635	2008	269	103	Mule Creek, North Sawmill Creek
OSN2636	2008	269	103	Mule Creek, Antelope Creek
OSN2637	2008	269	103	Mule Creek, Antelope Creek
OSN2638	2008	269	103	Mule Creek, Antelope Creek
OSN2639	2008	269	103	Mule Creek, Antelope Creek
OSN2640	2008	269	103	Mule Creek, Antelope Creek
OSN2641	2008	269	103	Mule Creek, Antelope Creek
OSN2642	2008	269	103	Mule Creek, North Sawmill Creek
OSN2643	2008	269	103	Mule Creek, Antelope Creek
OSN2644	2008	269	103	Mule Creek, Antelope Creek
OSN2645	2009	273	301	Mule Creek, Antelope Creek
OSN2646	2009	273	301	Mule Creek, North Sawmill Creek
OSN2647	2009	273	301	Mule Creek, Antelope Creek
OSN2648	2009	273	301	Mule Creek, Antelope Creek
OSN2649	2009	273	301	Mule Creek, Antelope Creek
OSN2650	2009	273	301	Mule Creek, Antelope Creek
OSN2651	2009	273	301	Mule Creek, Antelope Creek
OSN2652	2009	273	301	Mule Creek, Antelope Creek
OSN2653	2009	273	301	Mule Creek, Antelope Creek
OSN2654	2009	273	301	Mule Creek, Antelope Creek
OSN2655	2009	273	301	Mule Creek, North Sawmill Creek
OSN2656	2009	273	301	Mule Creek, Antelope Creek
OSN2657	2009	273	301	Mule Creek, Antelope Creek
OSN2658	2009	273	301	Mule Creek, Antelope Creek
OSN2659	2009	273	301	Mule Creek, North Sawmill Creek
OSN2660	2009	273	301	Mule Creek, Antelope Creek
OSN2661	2009	273	301	Mule Creek, Antelope Creek
OSN2662	2009	273	301	Mule Creek, North Sawmill Creek
OSN2663	2009	273	301	Mule Creek, Antelope Creek
OSN2664	2009	273	301	Mule Creek, North Sawmill Creek
OSN2665	2009	273	301	Mule Creek, Mule Mountains
OSN2666	2009	273	301	Mule Creek, Antelope Creek
OSN2667	2009	273	301	Mule Creek, Antelope Creek
OSN2668	2009	273	301	Mule Creek, Antelope Creek
OSN2669	2009	273	301	Mule Creek, North Sawmill Creek
OSN2670	2008	276	103	Mule Creek, Antelope Creek
OSN2671	2008	276	103	Mule Creek, Antelope Creek
OSN2672	2008	276	103	Mule Creek, Antelope Creek
OSN2673	2008	276	103	Mule Creek, Antelope Creek
OSN2674	2008	276	103	Mule Creek, Antelope Creek
OSN2675	2008	276	103	Mule Creek, Antelope Creek
OSN2676	2008	276	103	Mule Creek, Antelope Creek
OSN2677	2008	276	103	Mule Creek, Antelope Creek

Table A.3. Continued.

Lab Observation No.	Field Season	Field No.	Unit No.	Source
OSN2678	2008	276	103	Mule Creek, Antelope Creek
OSN2679	2008	276	103	Mule Creek, Antelope Creek
OSN2680	2008	276	103	Mule Creek, Antelope Creek
OSN2681	2008	276	103	Mule Creek, North Sawmill Creek
OSN2682	2008	276	103	Mule Creek, North Sawmill Creek
OSN2683	2008	276	103	Mule Creek, Antelope Creek
OSN2684	2008	276	103	Mule Creek, Antelope Creek
OSN2685	2008	276	103	Mule Creek, Antelope Creek
OSN2686	2008	276	103	Mule Creek, North Sawmill Creek
OSN2687	2008	276	103	Mule Creek, Antelope Creek
OSN2688	2008	276	103	Mule Creek, North Sawmill Creek
OSN2689	2008	276	103	Mule Creek, Antelope Creek
OSN2690	2008	276	103	Mule Creek, North Sawmill Creek
OSN2691	2008	276	103	Mule Creek, North Sawmill Creek
OSN2692	2008	276	103	Mule Creek, Antelope Creek
OSN2693	2008	276	103	Mule Creek, Antelope Creek
OSN2694	2008	276	103	Mule Creek, Antelope Creek
OSN2695	2009	277	301	Mule Creek, North Sawmill Creek
OSN2696	2009	277	301	Mule Creek, Antelope Creek
OSN2697	2009	277	301	Mule Creek, Antelope Creek
OSN2698	2009	277	301	Mule Creek, Antelope Creek
OSN2699	2009	277	301	Mule Creek, Antelope Creek
OSN2700	2009	277	301	Mule Creek, Antelope Creek
OSN2701	2009	277	301	Mule Creek, Antelope Creek
OSN2702	2009	277	301	Mule Creek, Antelope Creek
OSN2703	2009	277	301	Mule Creek, Antelope Creek
OSN2704	2009	277	301	Mule Creek, North Sawmill Creek
OSN2705	2009	277	301	Mule Creek, Antelope Creek
OSN2706	2009	277	301	Mule Creek, Antelope Creek
OSN2707	2009	277	301	Mule Creek, Antelope Creek
OSN2708	2009	277	301	Mule Creek, Antelope Creek
OSN2709	2009	277	301	Mule Creek, Antelope Creek
OSN2710	2009	277	301	Mule Creek, North Sawmill Creek
OSN2711	2009	277	301	Mule Creek, Antelope Creek
OSN2712	2009	277	301	Mule Creek, North Sawmill Creek
OSN2713	2009	277	301	Mule Creek, North Sawmill Creek
OSN2714	2009	277	301	Mule Creek, North Sawmill Creek
OSN2715	2009	277	301	Mule Creek, Antelope Creek
OSN2716	2009	277	301	Mule Creek, Antelope Creek
OSN2717	2009	277	301	Mule Creek, Antelope Creek
OSN2718	2009	277	301	Mule Creek, Antelope Creek
OSN2719	2009	277	301	Mule Creek, Antelope Creek
OSN2720	2009	280	301	Mule Creek, Antelope Creek
OSN2721	2009	280	301	Mule Creek, Antelope Creek
OSN2722	2009	280	301	Mule Creek, Antelope Creek
OSN2723	2009	280	301	Mule Creek, Antelope Creek
OSN2724	2009	280	301	Mule Creek, North Sawmill Creek
OSN2725	2009	280	301	Mule Creek, Antelope Creek
OSN2726	2009	280	301	Mule Creek, Antelope Creek
OSN2727	2009	280	301	Mule Creek, Antelope Creek
OSN2728	2009	280	301	Mule Creek, Antelope Creek
OSN2729	2009	280	301	Mule Creek, Antelope Creek

Table A.3. Continued.

Lab Observation No.	Field Season	Field No.	Unit No.	Source
OSN1293	2009	28	102	Mule Creek, Antelope Creek
OSN1294	2009	28	102	Mule Creek, Mule Mountains
OSN1295	2009	28	102	Mule Creek, Antelope Creek
OSN1296	2009	28	102	Mule Creek, Antelope Creek
OSN1297	2009	28	102	Mule Creek, Antelope Creek
OSN1298	2009	28	102	Mule Creek, Antelope Creek
OSN1299	2009	38	102	Mule Creek, Antelope Creek
OSN1300	2009	38	102	Mule Creek, Antelope Creek
OSN1301	2009	38	102	Mule Creek, Antelope Creek
OSN1302	2009	38	102	Mule Creek, Antelope Creek
OSN1303	2009	38	102	Mule Creek, Antelope Creek
OSN1304	2009	38	102	Mule Creek, Antelope Creek
OSN1305	2009	38	102	Mule Creek, Antelope Creek
OSN1306	2009	38	102	Mule Creek, Antelope Creek
OSN1307	2009	38	102	Mule Creek, Antelope Creek
OSN1308	2009	38	102	Mule Creek, Antelope Creek
OSN1309	2009	38	102	Mule Creek, Antelope Creek
OSN1310	2009	38	102	Mule Creek, Antelope Creek
OSN1311	2009	38	102	Mule Creek, Antelope Creek
OSN1312	2009	38	102	Mule Creek, Antelope Creek
OSN1313	2009	38	102	Mule Creek, Antelope Creek
OSN1314	2009	38	102	Mule Creek, Antelope Creek
OSN1315	2009	38	102	Mule Creek, Antelope Creek
OSN1316	2009	38	102	Mule Creek, Antelope Creek
OSN1317	2009	38	102	Mule Creek, Antelope Creek
OSN1318	2009	38	102	Mule Creek, Antelope Creek
OSN1319	2009	38	102	Mule Creek, Antelope Creek
OSN1320	2009	38	102	Mule Creek, Antelope Creek
OSN1321	2009	38	102	Mule Creek, Antelope Creek
OSN1322	2009	38	102	Mule Creek, Antelope Creek
OSN1323	2009	38	102	Mule Creek, Antelope Creek
OSN1324	2009	68	102	Mule Creek, Antelope Creek
OSN1325	2009	68	102	Mule Creek, Antelope Creek
OSN1326	2009	68	102	Mule Creek, North Sawmill Creek
OSN1327	2009	68	102	Mule Creek, Antelope Creek
OSN1328	2009	68	102	Mule Creek, Antelope Creek
OSN1329	2009	68	102	Mule Creek, Antelope Creek
OSN1330	2009	68	102	Mule Creek, Antelope Creek
OSN1331	2009	68	102	Mule Creek, Antelope Creek
OSN1332	2009	68	102	Mule Creek, Antelope Creek
OSN1333	2009	68	102	Mule Creek, Antelope Creek
OSN1334	2009	68	102	Mule Creek, Antelope Creek
OSN1335	2009	68	102	Mule Creek, Antelope Creek
OSN1336	2009	68	102	Mule Creek, Antelope Creek
OSN1337	2009	68	102	Mule Creek, Antelope Creek
OSN1338	2009	68	102	Mule Creek, Antelope Creek
OSN1339	2009	68	102	Mule Creek, Antelope Creek
OSN1340	2009	68	102	Mule Creek, Antelope Creek
OSN1341	2009	68	102	Mule Creek, Antelope Creek
OSN1342	2009	68	102	Mule Creek, Antelope Creek
OSN1343	2009	68	102	Mule Creek, Antelope Creek
OSN1344	2009	68	102	Mule Creek, Antelope Creek

Table A.3. Continued.

Lab Observation No.	Field Season	Field No.	Unit No.	Source
OSN0083	2009	162	–	Mule Creek, Antelope Creek
OSN0084	2009	167	–	Mule Creek, Antelope Creek
OSN0085	2009	167	–	Mule Creek, Antelope Creek
OSN1244	2009	2	102	Mule Creek, Antelope Creek
OSN1245	2009	2	102	Mule Creek, Antelope Creek
OSN1246	2009	2	102	Mule Creek, Antelope Creek
OSN1247	2009	2	102	Mule Creek, Antelope Creek
OSN1248	2009	2	102	Mule Creek, Antelope Creek
OSN1249	2009	4	102	Mule Creek, Antelope Creek
OSN1250	2009	4	102	Mule Creek, Antelope Creek
OSN1251	2009	4	102	Mule Creek, North Sawmill Creek
OSN1252	2009	4	102	Mule Creek, Antelope Creek
OSN1253	2009	4	102	Mule Creek, Antelope Creek
OSN1254	2009	4	102	Mule Creek, Antelope Creek
OSN1255	2009	4	102	Mule Creek, Antelope Creek
OSN1256	2009	4	102	Mule Creek, Antelope Creek
OSN1257	2009	4	102	Mule Creek, Antelope Creek
OSN1258	2009	4	102	Mule Creek, Antelope Creek
OSN1259	2009	4	102	Mule Creek, Antelope Creek
OSN1260	2009	4	102	Mule Creek, Antelope Creek
OSN1261	2009	4	102	Mule Creek, Antelope Creek
OSN1262	2009	4	102	Mule Creek, Antelope Creek
OSN1263	2009	4	102	Mule Creek, Antelope Creek
OSN1264	2009	4	102	Mule Creek, Antelope Creek
OSN1265	2009	4	102	Mule Creek, Antelope Creek
OSN1266	2009	4	102	Mule Creek, Antelope Creek
OSN1267	2009	4	102	Mule Creek, Antelope Creek
OSN1268	2009	4	102	Mule Creek, Antelope Creek
OSN1269	2009	4	102	Mule Creek, Antelope Creek
OSN1270	2009	4	102	Mule Creek, Antelope Creek
OSN1271	2009	4	102	Mule Creek, Antelope Creek
OSN1272	2009	4	102	Mule Creek, Antelope Creek
OSN1273	2009	4	102	Mule Creek, Antelope Creek
OSN1274	2009	28	102	Mule Creek, Antelope Creek
OSN1275	2009	28	102	Mule Creek, Antelope Creek
OSN1276	2009	28	102	Mule Creek, Antelope Creek
OSN1277	2009	28	102	Mule Creek, Antelope Creek
OSN1278	2009	28	102	Mule Creek, North Sawmill Creek
OSN1279	2009	28	102	Mule Creek, Antelope Creek
OSN1280	2009	28	102	Mule Creek, Antelope Creek
OSN1281	2009	28	102	Mule Creek, Antelope Creek
OSN1282	2009	28	102	Mule Creek, Antelope Creek
OSN1283	2009	28	102	Mule Creek, Antelope Creek
OSN1284	2009	28	102	Mule Creek, Antelope Creek
OSN1285	2009	28	102	Mule Creek, Antelope Creek
OSN1286	2009	28	102	Mule Creek, Antelope Creek
OSN1287	2009	28	102	Mule Creek, Antelope Creek
OSN1288	2009	28	102	Mule Creek, Antelope Creek
OSN1289	2009	28	102	Mule Creek, Antelope Creek
OSN1290	2009	28	102	Mule Creek, Antelope Creek
OSN1291	2009	28	102	Mule Creek, Antelope Creek
OSN1292	2009	28	102	Mule Creek, Antelope Creek

Table A.3. Continued.

Lab Observation No.	Field Season	Field No.	Unit No.	Source
OSN1293	2009	28	102	Mule Creek, Antelope Creek
OSN1294	2009	28	102	Mule Creek, Mule Mountains
OSN1295	2009	28	102	Mule Creek, Antelope Creek
OSN1296	2009	28	102	Mule Creek, Antelope Creek
OSN1297	2009	28	102	Mule Creek, Antelope Creek
OSN1298	2009	28	102	Mule Creek, Antelope Creek
OSN1299	2009	38	102	Mule Creek, Antelope Creek
OSN1300	2009	38	102	Mule Creek, Antelope Creek
OSN1301	2009	38	102	Mule Creek, Antelope Creek
OSN1302	2009	38	102	Mule Creek, Antelope Creek
OSN1303	2009	38	102	Mule Creek, Antelope Creek
OSN1304	2009	38	102	Mule Creek, Antelope Creek
OSN1305	2009	38	102	Mule Creek, Antelope Creek
OSN1306	2009	38	102	Mule Creek, Antelope Creek
OSN1307	2009	38	102	Mule Creek, Antelope Creek
OSN1308	2009	38	102	Mule Creek, Antelope Creek
OSN1309	2009	38	102	Mule Creek, Antelope Creek
OSN1310	2009	38	102	Mule Creek, Antelope Creek
OSN1311	2009	38	102	Mule Creek, Antelope Creek
OSN1312	2009	38	102	Mule Creek, Antelope Creek
OSN1313	2009	38	102	Mule Creek, Antelope Creek
OSN1314	2009	38	102	Mule Creek, Antelope Creek
OSN1315	2009	38	102	Mule Creek, Antelope Creek
OSN1316	2009	38	102	Mule Creek, Antelope Creek
OSN1317	2009	38	102	Mule Creek, Antelope Creek
OSN1318	2009	38	102	Mule Creek, Antelope Creek
OSN1319	2009	38	102	Mule Creek, Antelope Creek
OSN1320	2009	38	102	Mule Creek, Antelope Creek
OSN1321	2009	38	102	Mule Creek, Antelope Creek
OSN1322	2009	38	102	Mule Creek, Antelope Creek
OSN1323	2009	38	102	Mule Creek, Antelope Creek
OSN1324	2009	68	102	Mule Creek, Antelope Creek
OSN1325	2009	68	102	Mule Creek, Antelope Creek
OSN1326	2009	68	102	Mule Creek, North Sawmill Creek
OSN1327	2009	68	102	Mule Creek, Antelope Creek
OSN1328	2009	68	102	Mule Creek, Antelope Creek
OSN1329	2009	68	102	Mule Creek, Antelope Creek
OSN1330	2009	68	102	Mule Creek, Antelope Creek
OSN1331	2009	68	102	Mule Creek, Antelope Creek
OSN1332	2009	68	102	Mule Creek, Antelope Creek
OSN1333	2009	68	102	Mule Creek, Antelope Creek
OSN1334	2009	68	102	Mule Creek, Antelope Creek
OSN1335	2009	68	102	Mule Creek, Antelope Creek
OSN1336	2009	68	102	Mule Creek, Antelope Creek
OSN1337	2009	68	102	Mule Creek, Antelope Creek
OSN1338	2009	68	102	Mule Creek, Antelope Creek
OSN1339	2009	68	102	Mule Creek, Antelope Creek
OSN1340	2009	68	102	Mule Creek, Antelope Creek
OSN1341	2009	68	102	Mule Creek, Antelope Creek
OSN1342	2009	68	102	Mule Creek, Antelope Creek
OSN1343	2009	68	102	Mule Creek, Antelope Creek
OSN1344	2009	68	102	Mule Creek, Antelope Creek

Table A.3. Continued.

Lab Observation No.	Field Season	Field No.	Unit No.	Source
OSN1345	2009	68	102	Mule Creek, Antelope Creek
OSN1346	2009	68	102	Mule Creek, Antelope Creek
OSN1347	2009	68	102	Mule Creek, Antelope Creek
OSN1348	2009	68	102	Mule Creek, Antelope Creek
OSN1349	2009	81	102	Mule Creek, Antelope Creek
OSN1350	2009	81	102	Mule Creek, Antelope Creek
OSN1351	2009	81	102	Mule Creek, Antelope Creek
OSN1352	2009	81	102	Mule Creek, Antelope Creek
OSN1353	2009	81	102	Mule Creek, Antelope Creek
OSN1354	2009	81	102	Mule Creek, Antelope Creek
OSN1355	2009	81	102	Mule Creek, Antelope Creek
OSN1356	2009	81	102	Mule Creek, Antelope Creek
OSN1357	2009	81	102	Mule Creek, Antelope Creek
OSN1358	2009	81	102	Mule Creek, Antelope Creek
OSN1359	2009	81	102	Mule Creek, Antelope Creek
OSN1360	2009	81	102	Mule Creek, Antelope Creek
OSN1361	2009	81	102	Mule Creek, Antelope Creek
OSN1362	2009	81	102	Mule Creek, Antelope Creek
OSN1363	2009	81	102	Mule Creek, Antelope Creek
OSN1364	2009	81	102	Mule Creek, Antelope Creek
OSN1365	2009	81	102	Mule Creek, North Sawmill Creek
OSN1366	2009	81	102	Mule Creek, Antelope Creek
OSN1367	2009	81	102	Mule Creek, Antelope Creek
OSN1368	2009	81	102	Mule Creek, Antelope Creek
OSN1369	2009	81	102	Mule Creek, Antelope Creek
OSN1370	2009	81	102	Mule Creek, Antelope Creek
OSN1371	2009	81	102	Mule Creek, Antelope Creek
OSN1372	2009	81	102	Mule Creek, Antelope Creek
OSN1373	2009	81	102	Mule Creek, Mule Mountains
OSN1374	2009	85	102	Mule Creek, Antelope Creek
OSN1375	2009	85	102	Mule Creek, Antelope Creek
OSN1376	2009	85	102	Mule Creek, Antelope Creek
OSN1377	2009	85	102	Mule Creek, Antelope Creek
OSN1378	2009	85	102	Mule Creek, Antelope Creek
OSN1379	2009	85	102	Mule Creek, Antelope Creek
OSN1380	2009	85	102	Mule Creek, Antelope Creek
OSN1381	2009	85	102	Mule Creek, Antelope Creek
OSN1382	2009	85	102	Mule Creek, Antelope Creek
OSN1383	2009	85	102	Mule Creek, Antelope Creek
OSN1384	2009	85	102	Mule Creek, Antelope Creek
OSN1385	2009	85	102	Mule Creek, Antelope Creek
OSN1386	2009	85	102	Unknown 1
OSN1387	2009	85	102	Mule Creek, Antelope Creek
OSN1388	2009	85	102	Mule Creek, Antelope Creek
OSN1389	2009	85	102	Mule Creek, Antelope Creek
OSN1390	2009	85	102	Mule Creek, North Sawmill Creek
OSN1391	2009	85	102	Mule Creek, Antelope Creek
OSN1392	2009	85	102	Mule Creek, Antelope Creek
OSN1393	2009	85	102	Mule Creek, Antelope Creek
OSN1394	2009	85	102	Mule Creek, Antelope Creek
OSN1395	2009	85	102	Mule Creek, Antelope Creek
OSN1396	2009	85	102	Mule Creek, Antelope Creek

Table A.3. Continued.

Lab Observation No.	Field Season	Field No.	Unit No.	Source
OSN1397	2009	85	102	Mule Creek, Antelope Creek
OSN1398	2009	85	102	Mule Creek, Antelope Creek
OSN1399	2009	116	102	Mule Creek, Antelope Creek
OSN1400	2009	116	102	Mule Creek, Antelope Creek
OSN1401	2009	116	102	Mule Creek, Antelope Creek
OSN1402	2009	116	102	Mule Creek, Antelope Creek
OSN1403	2009	116	102	Mule Creek, Antelope Creek
OSN1404	2009	116	102	Mule Creek, Antelope Creek
OSN1405	2009	116	102	Mule Creek, Antelope Creek
OSN1406	2009	116	102	Mule Creek, Antelope Creek
OSN1407	2009	116	102	Mule Creek, Antelope Creek
OSN1408	2009	116	102	Mule Creek, Antelope Creek
OSN1409	2009	116	102	Mule Creek, Antelope Creek
OSN1410	2009	116	102	Mule Creek, Antelope Creek
OSN1411	2009	116	102	Mule Creek, Antelope Creek
OSN1412	2009	116	102	Mule Creek, Antelope Creek
OSN1413	2009	116	102	Mule Creek, Antelope Creek
OSN1414	2009	116	102	Mule Creek, Antelope Creek
OSN1415	2009	116	102	Mule Creek, Antelope Creek
OSN1416	2009	116	102	Mule Creek, Antelope Creek
OSN1417	2009	116	102	Mule Creek, Antelope Creek
OSN1418	2009	116	102	Mule Creek, Antelope Creek
OSN1419	2009	116	102	Mule Creek, Antelope Creek
OSN1420	2009	116	102	Mule Creek, Antelope Creek
OSN1421	2009	116	102	Mule Creek, Antelope Creek
OSN1422	2009	116	102	Mule Creek, Antelope Creek
OSN1423	2009	116	102	Mule Creek, Antelope Creek
OSN1424	2009	186	102	Mule Creek, Antelope Creek
OSN1425	2009	186	102	Mule Creek, Antelope Creek
OSN1426	2009	186	102	Mule Creek, Antelope Creek
OSN1427	2009	186	102	Mule Creek, Antelope Creek
OSN1428	2009	186	102	Mule Creek, Antelope Creek
OSN1429	2009	186	102	Mule Creek, Antelope Creek
OSN1430	2009	186	102	Mule Creek, Antelope Creek
OSN1431	2009	186	102	Mule Creek, Antelope Creek
OSN1432	2009	186	102	Mule Creek, Antelope Creek
OSN1433	2009	186	102	Mule Creek, Antelope Creek
OSN1434	2009	186	102	Mule Creek, Mule Mountains
OSN1435	2009	186	102	Mule Creek, Antelope Creek
OSN1436	2009	186	102	Mule Creek, Antelope Creek
OSN1437	2009	186	102	Mule Creek, Antelope Creek
OSN1438	2009	186	102	Mule Creek, Antelope Creek
OSN1439	2009	186	102	Mule Creek, Antelope Creek
OSN1440	2009	186	102	Mule Creek, Antelope Creek
OSN1441	2009	186	102	Mule Creek, Antelope Creek
OSN1442	2009	186	102	Mule Creek, Antelope Creek
OSN1443	2009	186	102	Mule Creek, Antelope Creek
OSN1444	2009	186	102	Mule Creek, Antelope Creek
OSN1445	2009	186	102	Mule Creek, Antelope Creek
OSN1446	2009	186	102	Mule Creek, Antelope Creek
OSN1447	2009	186	102	Mule Creek, Antelope Creek
OSN1448	2009	186	102	Mule Creek, Antelope Creek

Table A.3. Continued.

Lab Observation No.	Field Season	Field No.	Unit No.	Source
OSN1449	2009	202	102	Mule Creek, Antelope Creek
OSN1450	2009	202	102	Mule Creek, Antelope Creek
OSN1451	2009	202	102	Mule Creek, Antelope Creek
OSN1452	2009	202	102	Mule Creek, Antelope Creek
OSN1453	2009	202	102	Mule Creek, Antelope Creek
OSN1454	2009	202	102	Mule Creek, Antelope Creek
OSN1455	2009	202	102	Mule Creek, North Sawmill Creek
OSN1456	2009	202	102	Mule Creek, Antelope Creek
OSN1457	2009	202	102	Mule Creek, Antelope Creek
OSN1458	2009	205	102	Not obsidian
OSN1459	2009	205	102	Mule Creek, Antelope Creek
OSN1460	2009	205	102	Mule Creek, Antelope Creek
OSN1461	2009	205	102	Mule Creek, Antelope Creek
OSN1462	2009	205	102	Mule Creek, Antelope Creek
OSN1463	2009	205	102	Mule Creek, Antelope Creek
OSN1464	2009	205	102	Mule Creek, Antelope Creek
OSN1465	2009	205	102	Mule Creek, Antelope Creek
OSN1466	2009	205	102	Mule Creek, Antelope Creek

BERKELEY XRF LABORATORY REPORT

The analysis of 70 obsidian artifacts from two sites in the Mule Creek basin, New Mexico exhibits an assemblage dominated by sources in western New Mexico, particularly Mogollon-Datil Volcanic Province (Shackley 2005). These sites exhibit distinctive intrabasin procurement of obsidian raw material with five sources and source groups distributed differentially between the two sites. Small amounts of high elevation Mogollon Highlands Gwynn/Ewe Canyon obsidian in these sites suggests forays into this region, perhaps for hunting expeditions to augment the agricultural lifeway at Mule Creek.

Laboratory Sampling, Analysis, and Instrumentation

All archaeological samples are analyzed whole. The results presented here are quantitative in that they are derived from "filtered" intensity values ratioed to the appropriate x-ray continuum regions through a least squares fitting formula rather than plotting the proportions of the net intensities in a ternary system (McCarthy and Schamber 1981; Schamber 1977). More essentially, these data—through the analysis of international rock standards—allow for interinstrument comparison with a predictable degree of certainty (Hampel 1984; Shackley 2010).

All analyses for the current study were conducted on a ThermoScientific Quant'X EDXRF spectrometer, located in the Archaeological XRF Laboratory, El Cerrito, California. It is equipped with a thermoelectrically Peltier cooled solid-state Si(Li) X-ray detector, with a 50 kV, 50 W, ultra-high-flux end window bremsstrahlung, Rh target X-ray tube, and a 76µm (3 mil) beryllium (Be) window (air cooled), which runs on a power supply operating 4–50 kV/0.02–1.0 mA at 0.02 increments. The spectrometer is equipped with a 200 l min^{-1} Edwards vacuum pump, allowing for the analysis of lower-atomic-weight elements between sodium (Na) and titanium (Ti). Data acquisition is accomplished with a pulse processor and an analogue to digital converter. Elemental composition is identified with digital filter background removal, least squares empirical peak deconvolution, gross peak intensities, and net peak intensities above background.

Table A.4. Summary of Missouri University Research Reactor Laboratory (MURR) obsidian sourcing results from the 3-Up site, LA 150373, and Gamalstad, LA 164472, by site, source, and source locality.

Site	Antelope Creek (Mule Creek)	N Sawmill Creek (Mule Creek)	Mule Mountains (Mule Creek)	Cow Canyon	Gwynn Canyon	Unknown 1	Total
3-Up	1,011 (77.41%)	279 (21.36%)	10 (0.77%)	2 (0.15%)	0 (0.00%)	4 (0.31%)	1,306 (100.00%)
Gamalstad	244 (94.94%)	8 (3.11%)	3 (1.17%)	0 (0.00%)	1 (0.39%)	1 (0.39%)	257 (100.00%)
Total	1,255 (80.29%)	287 (18.36%)	13 (0.83%)	2 (0.13%)	1 (0.06%)	5 (0.32%)	1,563 (100.00%)

Note: Does not include six submitted samples that were unassigned due to size or other factors and six submitted samples that were not obsidian.

The analysis for mid Zb condition elements Ti-Nb, Pb, Th, the x-ray tube is operated at 30 kY, using a 0.05 mm (medium) Pd primary beam filter in an air path at 200 seconds livetime to generate x-ray intensity Ka-line data for elements titanium (Ti), manganese (Mn), iron (as Fe203T), cobalt (Co), nickel (Ni), copper, (Cu), zinc, (Zn), gallium (Ga), rubidium (Rb), strontium (Sr), yttrium (Y), zirconium (Zr), niobium (Nb), lead (Pb), and thorium (Th). Not all these elements are reported, however, as their values in many volcanic rocks are very low. Trace element intensities were converted to concentration estimates by employing a least-squares calibration line ratioed to the Compton scatter established for each element from the analysis of international rock standards certified by the National Institute of Standards and Technology (NIST), the U.S. Geological Survey (USGS), the Canadian Centre for Mineral and Energy Technology, and the Centre de Recherches Petrographiques et Geochimiques in France (Govindaraju 1994). Line fitting is lineaT (XML) for all elements but Fe, where a derivative fitting is used to improve the fit for iron and thus for all the other elements. When barium (Ba) is analyzed in the High Zb condition, the Rh tube is operated at 50 kY and up to 1.0 rnA, ratioed to the bremsstrahlung region (see Davis et al. 2010; Shackley 2010).

Further details concerning the petrological choice of these elements in Southwest obsidian is available in Shackley (1988, 1995, 2005; also Hughes and Smith 1993; Mahood and Stimac 1991). Nineteen specific pressed powder standards are used for the best fit regression calibration for elements Ti-Nb, Pb, Th, and Ba, including G-2 (basalt), AGV-2 (andesite), GSP-2 (granodiorite), SY-2 (syenite), BHVO-2 (hawaiite), STM-I (syenite), QLO-I (quartz latite), RGM-I (obsidian), W-2 (diabase), BIR-I (basalt), SDC-I (mica schist), TLM-I (tonalite), SCO-I (shale), NOD-A-I, and NOD-P-I (manganese), all US Geological Survey standards; NIST-278 (obsidian), U.S. National Institute of Standards and Technology; BE-N (basalt) from the Centre de Recherches Petrographiques et Geochimiques in France; and JR-I and JR-2 (obsidian) from the Geological Survey of Japan (Govindaraju 1994).

Data from the WinTrace software were translated directly into Excel for Windows software for manipulation and into SPSS for Windows for statistical analyses. To evaluate the quantitative determinations, machine data were compared to measurements of known standards during each run. RGM-I a USGS obsidian standard is analyzed during each sample run for obsidian artifacts to check machine calibration (see Table A.1). Source assignments were made by reference to Shackley (1995, 1998a, 2005; see also Shackley 2010:Tables 1–2, Figures 1, 2, and 7), as well as source standard data at this lab.

Analytical Trajectory

Because most of the obsidian artifacts from the two sites were expected to have been produced from one of the three main Mule Creek source groups, a re-analysis of source standard obsidian from the three source groups (Antelope Creek, Mule Mountains, and North Sawmill Creek) was conducted prior to the analysis of archaeological material. These were samples collected in the 1980s, 1990s, and during surveys in 2009 and 2010 with the Center for Desert Archaeology (now Archaeology Southwest) (Shackley 2005). While it is well known that these three compositional groups (plus on other) present in the San Francisco River alluvium are likely derived from the same magma source, two of those sources, Antelope Creek and Mule Mountains, exhibit very similar elemental composition. Every attempt was made to separate these groups, as shown in Shackley (2010:Figure 3).

What is less well understood is the similarity in elemental composition between the Mule Creek sources and other sources in the Mogollon-Datil Volcanic Province of western New Mexico (McIntosh et al. 1992; Shackley 2005). Recent isotopic studies of the Mogollon-Datil rhyolites indicate substantial isotopic variability that is not evident in the major, minor, and trace elements (Shackley 2009, 2010:Figure 2). The analyses of four stable isotopes shown in Shackley (2010:Figure 4) indicate that while Antelope Creek and Mule Mountains are similar elementally, they are likely derived from very different magma chemistry either due to fractionation and/or chronology. Clarity in the isotopic variability will be evident when the *40Arr*Ar dating, currently underway, is complete. Nevertheless, it is possible to discriminate these two chemical groups using the elements yttrium, niobium, and, to a lesser extent, rubidium and barium (see Shackley 1998a, 2005).

To effectively discriminate the large number of sources, a combination of a multivariate statistical analysis (hierarchical cluster) and bivariate plots of the elements was used in tandem. For the cluster analysis, only those elements with relatively large variability were entered into the analysis—in this case, Rb, Sr, Y, and Nb. The cluster groupings were generally mirrored in the plots (Shackley 2010:Figures 1–2).

Sources

The Mogollon-Datil Province and the Mule Creek Area

The Mule Creek source region is one of the most geologically explored archaeological sources of obsidian in the American Southwest (Figure A.2) (Brooks and Ratté 1985; Ratté 1982; Ratté and Brooks 1983, 1989; Ratté and Hedlund 1981; Rhodes and Smith 1972). Ratté (1982) has organized most of the research in the area focusing on mapping and establishing the origin of the volcanics during the Tertiary as originally described by Rhodes and Smith (1972). This region, which is on the boundary between the Basin and Range complex to the west and southwest, and the southeastern edge of the Colorado Plateau, exhibits a silicic geology that is somewhat distinctive, from the decidedly peraluminous glass of Cow Canyon with relatively high strontium values and the distinct chemical variability of the Mule Creek glasses (Elston et al. 1976; Ratté et al. 1984; Rhodes and Smith 1972; Shackley 2005).

The province has been named Mogollon-Datil for its location and major floristic association (Elston et al. 1976). The region is, in part, characterized by pre-caldera andesites and later high-silica alkali rhyolites in association with caldera formation, subsequent collapse, and post-caldera volcanism. Most recently, fieldwork and chemical analyses by Ratté and Brooks (1989) lead them to conclude that the Mule Creek Caldera is actually just a graben, although the typical succession from intermediate to silicic volcanism apparently holds. The obsidian has been directly dated at the Antelope Creek locality (Locality 1 in Shackley 2010:Figure 3.5) to 17.7±0.6 mya by K-Ar and at the Mule Mountain locality at the same age (17.7±1 mya by K-Ar; Ratté and Brooks 1983, 1989). A single obsidian marekanite taken from the perlitic lava at the Antelope Creek locality was used in the analysis. Unusual in geological descriptions, the obsidian proper was discussed as an integral part of the regional geology.

Aphyric, high-silica, alkali-rhyolite domal flows from the Harden Cienega eruptive center along the southwestern border of the Wilson Mountain, New Mexico 1:24,000 topographic quadrangle. Unit ob, commonly at the base of the flows, consists of brown, pumiceous glass that grades upward into gray to black perlitic obsidian and obsidian breccia. Extensive ledges of partly hydrated, perlitic obsidian contain nonhydrated obsidian nodules (marekenites), which, when released by weathering, become the Apache tears that are widespread on the surface and within the Gila Conglomerate in this region. Age shown in correlation is from a locality about 1 km south of the tank in Antelope Creek in the Big Lue Mountains quadrangle adjacent to the western edge of the Wilson Mountain quadrangle. Thickness of flows is as much as 60 m and as much as 25 m in Unit ob (Ratté and Brooks 1989).

This description adequately characterizes what is found at the other two primary localities (Mule Mountains and Mule Creek/North Sawmill Creek). Aphyric, artifact quality marekenites are remnant within perlitic glass and tuff lava units. Nodules at all localities are up to 15 cm in diameter, although most are less than 10 cm. The devitrified perlitic lava, quite friable, erodes easily into the local alluvium. As discussed elsewhere, this is relatively unique in Tertiary sources in the Southwest where most of the obsidian breccia and perlitic

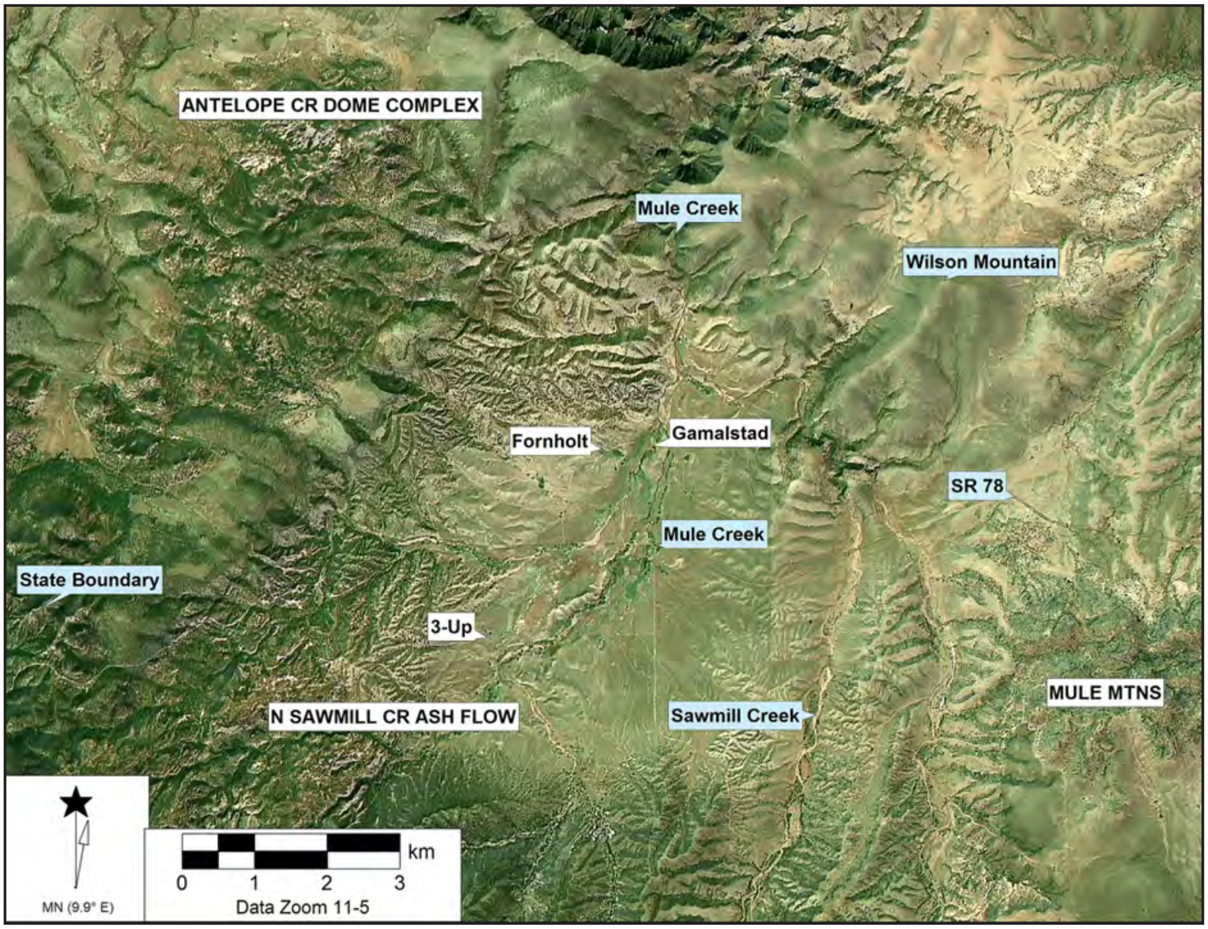

Figure A.2. Map of Mule Creek sites in relation to Mule Creek obsidian localities.

lava is often completely eroded, leaving only the rhyolite interior of the dome and a consequent inability to assign the surrounding marekenites to a specific dome structure (Shackley 2005; see also Hughes and Smith 1993).

The aphyric glass ranges from opaque black to translucent smoky gray with some gray banding. In more than 1,000 specimens collected from the Mule Creek/North Sawmill Creek group, three are mahogany brown and black banded similar to Slate Mountain (Wallace Tank) material. Some of the cortex exhibits a silver sheen, but most is a thin black-brown. The material is a fair medium for tool production, although it is very brittle, much like Los Vidrios. The pressure reduction potential is, however, very good, as seen in the sites in the current study. The Mule Mountain glass is as good as any in the Southwest, although surprisingly relatively rare in sites tested in the basin.

One of the most startling discoveries in the 1990s was the chemical variability in Mule Creek obsidian (Shackley 1995, 1998b). In earlier studies, two "outliers" collected at Mule Creek were found with significantly higher rubidium concentration values (Shackley 1988:767). These outliers have now been identified as a distinct chemical group, often mixed in the regional Gila Conglomerate with three other chemical groups. The geology in the area is complex and has been studied by Ratté (1982) and others for some time (see also Brooks and Ratté 1985; Ratté and Brooks 1983, 1989; Ratté and Hedlund 1981; Rhodes and Smith 1972). Primary in situ perlite localities for three of the chemical groups have been located, but the secondary distribution of these source groups within the Mule Creek Basin is less well understood.

At least four distinct chemical groups are evident, distinguished by Rb, Y, Nb, and Ba, and, to a lesser extent, Sr and Zr elemental concentrations are named after the localities where marekanites have been found in perlitic lava: Antelope Creek, Mule Mountains, and Mule Creek/North Sawmill Creek—all in New Mexico (see Shackley 1995, 1998b, 2010:Figures 2, 4). The obsidian at the Antelope Creek locality and adjacent secondary deposits constitutes the volumetrically largest source of all the Mule Creek sources. The Tertiary-age dome complex at Antelope Creek covers hundreds of hectares, virtually all of which exhibits artifact quality marekanites. Surveys to the west in the Big Lue Mountains on the Arizona-New Mexico state line indicate a mix of North Sawmill Creek and Antelope Creek marekanites in secondary alluvium at a ratio of about six North Sawmill Creek to one Antelope Creek, similar to the ratio reported in Shackley (1988). The Antelope Creek eruptive event approximately 17 million years ago was quite extensive.

In addition, during the 1994 field season, a fourth subgroup was discovered in the San Francisco River alluvium near Clifton, Arizona and in older alluvium between Highway 191 and Eagle Creek in western Arizona north of Clifton provisionally called San Francisco River nodules. While in situ nodules have not yet been found, they are located somewhere west of Blue River and north and west of the San Francisco River, as none of this low zirconium subgroup was discovered in alluvium upstream from the juncture of the Blue River and San Francisco River. The relationship between the Mule Creek localities is apparent in the bivariate plots of trace elements (Shackley 2010:Figures 1–2), and it signifies the complex nature of the Mule Creek silicic geology, with subsequent depositional mixing in the Gila Conglomerate.

Glass at other Tertiary sources in the Southwest, such as Sauceda Mountains and Antelope Wells, also appear to exhibit more than one chemical mode, although not as distinct as Mule Creek or Mount Taylor, discussed below (Shackley 1988, 1990, 1998b). The Mule Creek case is unusual because the chemical groups are not always spatially discrete, and they occur together in the extensive Gila Conglomerate, which is composed primarily of Mule Creek rhyolite and tuffs in the area where the marekanites do occur (see Ratté and Brooks 1989).

Gwynn/ Ewe Canyon

The Gwynn/Ewe Canyon source is located in Gila National Forest, south Catron County, New Mexico, at more than 2,500 m elevation (Shackley 2005). In an early study (Shackley 1988), this source was not mapped or surveyed. A more recent survey in 1993 indicated that marekanites were directly associated with glassy, perlitic rhyolite in Ewe Canyon to the south, although this stream system erodes into Gwynn Canyon. Coalesced domes on Feathery Hill exhibit nodule densities in the regolith up to 200 per m^2. This source is located in the 1963 7.5-minute Telephone Canyon Catron County, New Mexico topographic quadrangle. Unmodified marekanites on the domes have maximum diameters near 50 mm, although most (circa 95 percent) are 30 mm and smaller. Bipolar cores and flakes were found on and near Feathery Hill, but in low densities <1 per 100 m^2.

As noted, marekanites are eroding into the Gwynn Canyon system and possibly into the upper San Francisco River as weell, although no nodules were noted in the San Francisco River alluvium as far north as Alma, New Mexico.

The Gwynn/Ewe Canyon and two of the Mule Creek groups (Antelope Creek and Mule Mountains) are very similar in trace element composition (see Shackley 1995, 1998b). Zirconium plotted against Nb, Y, and/or Ba is the best method to discriminate these sources using XRF. This can be an important issue in western New Mexico late prehistory, as these sources are located in different environments, which may have had cultural significance in prehistory. In the Mogollon Classic period, Gwynn/Ewe Canyon obsidian could have been controlled by the Cibola branch of the Mogollon while the Mule Creek sources could have been controlled by the Mimbres branch. This may or may not influence the spatial distribution of these obsidian sources in the region, and confident source assignment can become crucial. Gwynn/Ewe Canyon obsidian found at elevations above 2,500 m in elevation is generally well above the elevation favoring maize cultivation, and there are virtually no large settlements above this elevation. Hunting large ungulates, however, is likely in the area. Both deer and elk were seen in the area in the 1990s.

DISCUSSION

While it is not surprising that the 3-Up and the Gamalstad sites were dominated by local obsidian—indeed, obsidian marekanites are available essentially on-site—the dominance of the Antelope Creek chemical group is surprising, because Mule Mountains obsidian is probably a better raw material for flaked stone tool production (see Shackley 2010:Tables 2–3, Figures 2, 4, 5). Evidently, the on-site availability of Antelope Creek obsidian outweighed differences in raw material quality. Further, the North Sawmill Creek group is only relatively well-represented at the 3-Up site; Antelope Creek remains the dominant source, although the North Sawmill Creek locality is very close to the 3-Up site (see Shackley 2010:Figures 2, 4). This lends more credence to local (on-site) procurement of Antelope Creek obsidian. The local versus nonlocal inference must be tested with a thorough survey of the stream systems in the basin to determine the extent of the secondary distribution of these three chemical groups.

The trace presence of Gwynn/Ewe Canyon and Cow Canyon obsidian at these two sites is interesting. Were residents importing the finished tools or producing tools brought from these sources while on hunting expeditions or obtained in exchange from people closer to the source? The obsidian source provenance in these sites, while seemingly dominated by local materials, could yield more interesting information when the secondary distribution of these three chemical groups in stream systems (that is, Mule Creek, North Sawmill Creek, and Mule Mountains) near these sites is more fully understood. Regardless, the Antelope Creek chemical group is culturally dominant. Although volumetrically, Antelope Creek is far larger than the other two groups, this is not necessarily a good measure of prehistoric use (see Shackley 2005).

Finally, this study, as well as other large obsidian provenance studies in the region, strongly suggest the Antelope Creek obsidian locality at Mule Creek was a dominate obsidian source in the late Classic period (Clark, Shackley, Hill et al. 2012; Mills et al. 2013; Taliafero et al. 2010). Whether the inhabitants at Mule Creek at this time used this commodity to economic advantage could be inferred, although it needs to be verified with other data sets and more work. Antelope Creek was likely dominant because there is so much obsidian at the dome complex and the inhabitants of these two sites were essentially on top of the source, and they could easily control access, similar to the situation with the Superior (Picketpost Mountain) source in central Arizona (Shackley 2005). Indeed, the 3-Up site is the only major fourteenth century occupation identified to date in the Mule Creek basin, when obsidian from this source was distributed widely across the southern Southwest as part of the Salado phenomenon.

Acknowledgments

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APPENDIX B

DESCRIPTIONS OF GROUND STONE ARTIFACTS AND MINERALS FROM THE 3-UP SITE, LA 150373, AND GAMALSTAD, LA 164472

Lauren Falvey

Table B.1. Descriptions of ground stone artifacts and minerals from the 3-Up site, LA 150373, and Gamalstad, LA 164472.

Site, Feature No.	FN	Strat	Artifact	Comments
3-Up, LA 150373				
4	101.01	50	Mano/abrader	Cobble with pecking along the edges for holding and the start of surface manufacture on one side but did not get the surfaces flat; lightly used on one side; one end tapers and has a natural concave surface; seems something was pulled back and forth against the surface; striations run from the concavity toward the center of the piece
4	101.02	50	Abrader	Flat stone with wear facets from use as an abrader; fine-textured stone probably used more to smooth; several striations going off in random directions; used against a hard surface
?	104.01	50	Lapstone	Tabular shaped piece with use as a lapstone on both sides; probably used to abrade and shape something hard like shell; very rough asperite material
?	104.02	50	Unidentified	Large piece of tuff with a slightly convex surface on one side; only small areas of abrasion are actually visible microscopically so hard to tell actual activity; may have been used as a handstone or lapstone; the opposite surface is rough and would not have been comfortable to hold for any period
1	6	50	Abrader	Small piece of shaped tuff with one U-shaped groove running its length; the groove and the perimeter of the piece were pecked to shape; hand-wear is present on the back and sides; abrasive material probably used to smooth a shaft rather than straighten it (Figure B.1)
1	38	50	Netherstone	Large angular tabular piece with use on both surfaces for grinding red (10R 4/6) and yellow (10YR 7/8) pigment; most of the pigment is on one surface; may have been used in a different processing activity on both sides to produce the leveling and the pigment was worked after; one edge has several flakes removed for an unknown purpose; a few spots along his edge have grinding and pigment but it is otherwise unused; the flakes also seem to be somewhat sporadic; cultural, not the result of excavation
1	70	50	Netherstone/scraper	Somewhat tabular piece of fine-grained stone used on both sides as a netherstone; used to grind red pigment (2.5YR 4/8) on one side, among other hard items that left striations and gouges; one margin was secondarily flaked to make a thick convex edge used as a scraper; the wear over the edge suggests it was used to scrape hides, and other spots along the margin also look like they were used in hide processing; very large scraper; there is some unusual milky, clear residue on some areas of the edge and surface that may have been left from use; lots of hand-wear on the margins (Figures B.2–B.3)
?	257	61	Mano	Vesicular basalt rectangular trough mano used only enough to level the uppermost asperities on both sides but not enough to reach the slightly lower asperities; used against a slightly concave metate with low trough sides; pecked to hold; mapped as Mano 1
2	58	50	Mano/lapstone	Rectangular cobble mano; almost completely covered in thick caliche, which obscured the stone surface and wear; cannot determine what type of mano, but it could be either flat or trough; edges are ground to hold; after it broke, the mano surface was used as a lapstone to process pigment; cannot determine exactly how much pigment due to the caliche, but most areas scratched with a pick revealed underlying red (2.5YR 4/6); a few random black char marks are also present on the mano surface, but they run over the caliche and probably resulted from it being in a trash context or from roots burning near it in the soil
3	283	16	Chinking stone	Piece of tabular material with two fresh edge breaks and three chips taken from one corner; bag note says it was "from wall," so it was probably used as a chinking stone
4	145	59	Unidentified	Piece of tuff with a convex curve on one surface; microscopic use-wear shows nothing, but the curve is not natural for the material
4	155	50	Crystal	Unmodified quartz crystal with one broken end (Figure B.4)

Table B.1. Continued.

Site, Feature No.	FN	Strat	Artifact	Comments
?	205	4	Raw material	Small piece of unmodified pigment material; 10R 4/8; would have been tossed as a rock if there were not so many artifacts with pigment on them from the site
5	127	50	Polisher/lapstone	Polisher handstone; palm-sized rock with pecking in a few areas of the sides with hand-wear over them; used in a burnishing activity in multiple areas; trace amounts of red/orange pigment were visible through the microscope but are too minute to Munsell; used as a lapstone secondarily to abrade a small amount of pigment
5	134.01	50	Mano	Flat/concave mano used on one side; made of a rough, unattractive material and recycled as a fire-cracked rock
5	134.02	50	Lapstone	Flattish river cobble with a few spots where something small was burnished on the surface; very fine-grained, smooth material; possibly stone ornament manufacture
5	134.03	50	Chinking stone	Unmodified, thin tabular piece of stone; not curated
5	140	50	Mano	One-quarter of a flat/concave mano used on both sides; recycled as a fire-cracked rock
5	168	50	Netherstone	Piece of either a mortar or basin metate, which was secondarily used to hold paint; the piece is too small to determine what it was originally, but it has a border, so use was either as a metate or mortar; after it fragmented, part of the artifact was used to hold red paint (2.5YR 4/8); it then broke again into the smaller piece that remains; the paint dripped over one side and is also present on the border
5	169	50	Lapstone	Tabular piece of stone with chipped edges to shape; missing two edges; used on both sides to process or mix pigment; two colors, yellow (10YR 7/8) and red (10R 4/6); the colors are segregated on the lapstone, but there is a small area of overlap where they meet; the opposite side only has a small area of red pigment; small amount of grinding on the side with just red pigment, more from shaping than actually grinding the pigment; hand-wear on one edge and one corner; pigment was not quite paint but not in the early stages of processing (Figure B.5)
Gamalstad, LA 164472				
?	41	4	Chinking stone	Tabular piece of material that narrows at one edge; narrow edge has a few chips removed either from use or to shape the chinking stone; not curated
?	372	4	Indeterminate	Corner chunk from something, but not enough remains to determine from what; has some rounding on both surfaces and a shallow groove around the margin that also has wear; not enough left to determine the function of the groove
1	39	50	Abrader	Piece of scoria with a small area that was expediently used to abrade a hard surface
1	53	50	Chinking stone	Tabular stone with a few chips removed from either side of one corner; all edge breaks are fresh; probably collected as a chinking stone
1	66	50	Mano/netherstone	Slightly oval to rectangular vesicular basalt trough mano used to a point on either end; used with a shallow trough; secondarily used on one side as netherstone to process pigment between another stone; 2.5YR 5/8; one edge has a few flakes removed as if it were being prepared as a chopper edge, but it was not used
1	72.01	50	Mano	Part of a vesicular basalt mano; no wear going over one intact end so may be part of a flat mano but not enough left to be sure
1	72.02	50	Metate	Fragment from an indeterminate type metate; may have been part of an edge that was re-widened but not enough left to tell; retains quite a bit of sheen and a concave surface
1	72.03	50	Lapstone	Small broken stone with the start of a concave lapstone surface; worked with something hard but not very asperite, maybe even shell; spots near the edges also used to polish something; pecked around the edges to shape
1	72.04	50	Mano	Chunk of an indeterminate type mano with a little wear that curves over an end either from rocking or trough contact

Table B.1. Continued.

Site, Feature No.	FN	Strat	Artifact	Comments
1	83	50	Unidentified	Small piece of tuff with some grinding on either side; too small of a piece to determine artifact type
1	96	50	Abrader	Small piece of tuff with one area used as an abrader, which wore down a dip in the material; the tuff is very soft, and this probably did not take much use
1	103.01	50	Raw material	Roundish tabular piece of ash with no signs of wear, but it could have been a pot lid
1	103.02	50	Netherstone	Chunk of vesicular material with a small amount of limonite pigment on one side; 7.5YR 6/8
1	114	50	Unidentified	Piece of tuff with some grinding on one side; no directionality to indicate use
1	115	50	Mano	Middle section of a vesicular basalt mano with a finger groove manufactured on either edge; hand-wear in the groove; probably used against a fairly flat surface, but do not have the ends to be able to determine if it was a flat or a trough metate
1	124	50	Raw material	Square tabular piece of light stone that does not show any signs of wear but is the right shape for a pot lid or a small pit lid
1	129.01	50	Chopper	Tabular stone with heavy chipping on one edge; use-wear on the edge looks like it was used against a soft material with stone beneath; both sides have been ground somewhat smooth, and it looks like the back may have been wrapped with leather; the leather wrap rubbed against the piece, indicating the edge may have been worn down enough from use to require resharpening, which obscured most of the wear
1	129.02	50	Lapstone	Tabular piece of stone similar to the chinking materials but with use as a lapstone on both sides and a small ground corner; stone manufacturing activity, possibly polishing something
1	129.03	50	Shaped	Tabular piece of stone with grinding that curves around one edge; striations are perpendicular to the edge, and the asperities were frosted; not a polishing activity; an unusual piece
1	129.04, 05	50	Chinking	Two pieces of tabular chinking stone; both have ground areas that may have resulted from the abrasion of them being placed between other rocks; not curated
1	129.06, 07	50	Chinking	Two tabular pieces of chinking stone with no wear of manufacture marks; not curated
3	187	10FF	Handstone	Broken cobble with use as a handstone on one side and some secondary use against a smoother material that left a sheen similar to trough wear curving around the intact sides; the first activity was processing, and the second was probably manufacturing
6	158	10	Unidentified	Small piece of vesicular basalt with some leveling and sheen; too small a piece to determine the original design/use

Table B.2. Ground stone artifact types from the 3-Up site, LA 150373, and Gamalstad, LA 164472.

	3-Up		Galamstad		Total	
Type	No.	Percent	No.	Percent	No.	Percent
Abraders	2	12.5	2	10.5	4	11.4
Architectural stones	2	12.5	6	31.6	8	22.9
Choppers	0	0.0	1	5.3	1	2.9
Handstones	0	0.0	1	5.3	1	2.9
Lapstones	3	18.8	2	10.5	5	14.3
Manos	5	31.3	4	21.1	9	25.7
Metates	0	0.0	1	5.3	1	2.9
Netherstones	3	18.8	1	5.3	4	11.4
Polishers	1	6.3	0	0.0	1	2.9
Shaped	0	0.0	1	5.3	1	2.9
Subtotal[a]	*16*	*100.0*	*19*	*100.0*	*35*	*100.0*
Crystals	1	25.0	0	0.0	1	9.1
Unidentified	2	50.0	5	71.4	7	63.6
Raw material	1	25.0	2	28.6	3	27.3
Subtotal[a]	*4*	*100.0*	*7*	*100.0*	*11*	*100.0*
Grand Total[b]	20	43.5	26	56.5	46	100.0

[a]Percentages of subtotaled artifacts.
[b]Totals and percent of all artifacts.

Table B.3. Ground stone artifact material types from the 3-Up site, LA 150373, and Gamalstad, LA 164472.

	3-Up		Galamstad		Total	
Type	No.	Percent[a]	No.	Percent[a]	No.	Percent[b]
Andesite	4	22.2	10	47.6	14	35.9
Dacite	4	22.2	3	14.3	7	17.9
Granodiorite	1	5.6	0	0.0	1	2.6
Quartz	1	5.6	0	0.0	1	2.6
Quartzite	0	0.0	1	4.8	1	2.6
Rhyolite	3	16.7	2	9.5	5	12.8
Vesicular basalt	1	5.6	3	14.3	4	10.3
Volcanic	4	22.2	1	4.8	5	12.8
Volcanic breccia	0	0.0	1	4.8	1	2.6
Grand Total[b]	18	100.0	21	100.0	39	100.0

[a]Percentages of subtotaled artifacts.
[b]Totals and percent of all artifacts.

Figure B.1. Grooved abrader from Feature 1, the 3-Up site, LA 150373.

Figure B.2. Lapstone for hide scraping from Feature 1, the 3-Up site, LA 150373.

Figure B.3. Lapstone for hide scraping from Feature 1 close-up edge, the 3-Up site, LA 150373.

Figure B.4. Quartz crystal from Feature 4, the 3-Up site, LA 150373.

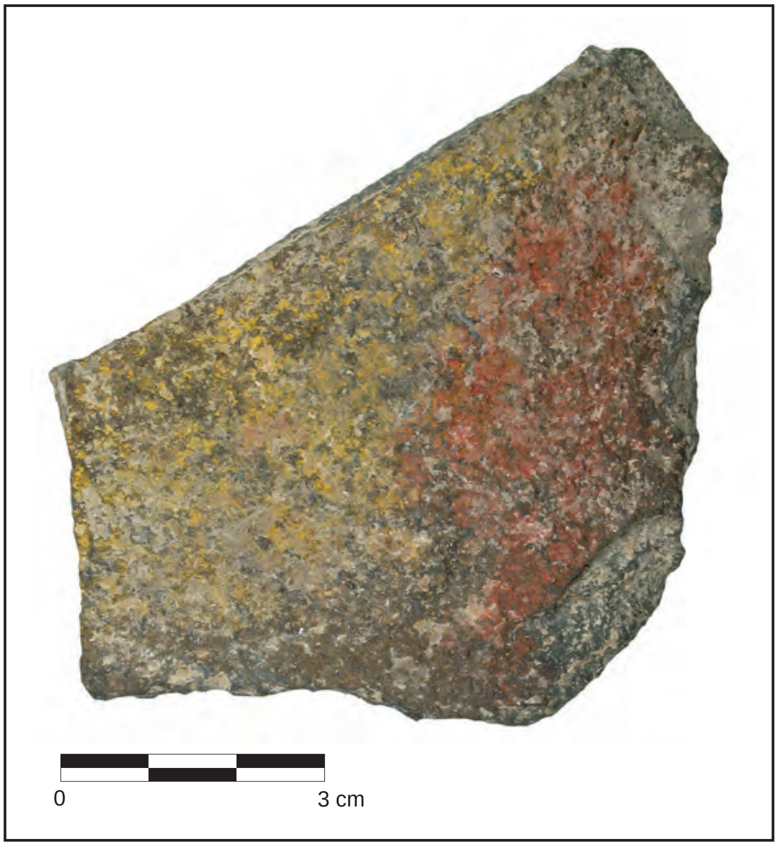

Figure B.5. Lapstone for grinding pigment from Feature 5, the 3-Up site, LA 150373.

SHELL ARTIFACTS FROM THE 3-UP SITE, LA 150373, AND THE GAMALSTAD SITE, LA 164472

Christine H. Virden-Lange

Three marine shell (Keen 1971) ornaments were recovered from Locus B at the 3-Up site, LA 150373, during the current project (Table C.1). Two are *Glycymeris* sp. bracelet fragments; the other is a complete *Olivella dama* bead (Figure C.1).

The Gamalstad site, LA 164472, produced a larger shell assemblage—13 pieces representing 11 individual specimens. Of these, six are *Glycymeris* sp., one is *Argopecten circularis*, one is an unidentified marine bivalve, one is freshwater *Anodonta californiensis* (Bequaert and Miller 1973), and two are unidentified nacreous (possibly *Anodonta*).

The marine shell appears to have come from the Gulf of California, the same source the Hohokam utilized. The freshwater shell identified as *Anodonta* would come from a nearby stream with continual water flow, as it needs a particular host fish to generate offspring. Because the shell is very fragile and breaks easily, it was likely derived locally, probably from Mule Creek or Tennessee Creek.

Because no manufacturing debris or in-process ornaments are present in the collection, the ornaments almost certainly arrived in a finished state, although this is a small sample. However, Mogollon/Mimbres sites usually do not have much evidence of manufacturing; rather, they acquired their jewelry already made, probably by bartering.

Table C.1. Shell collections from the 3-Up site, LA 150373, and Gamalstad, LA 164472.

Site, Locus	Feature No.	Unit No.	Context	Artifact	Species	Count	MNI[a]	Source	Figure No.
3-Up, LA 150373									
B	0	0	Surface	Plain bracelet	*Glycymeris* sp.	1	1	Gulf of California / California coast	–
B	0	103	Cultural sheet trash	Plain bracelet	*Glycymeris* sp.	1	1	Gulf of California / California coast	–
B	4	104	Trash concentration	Whole shell bead	*Olivella dama*	1	1	Gulf of California	C.1a
Subtotal						*3*	*3*		
Gamalstad, LA 164472									
0	1	101	Surface	Disk bead	Unidentified marine bivalve	1	1	–	C.1b
0	1	101	Fill of primary extramural feature	Cut-shell pendant, oval	*Argopecten circularis*	1	1	Gulf of California	C.1c
0	1	101	Fill of primary extramural feature	Cut-shell, geometric, unknown	Unidentified nacreous (cf. *Anodonta*)	1	1	–	C.1d
0	0	106	Sheet trash with cultural material	Cut-shell pendant, geometric	Unidentified nacreous (cf. *Anodonta*)	1	1	–	C.1e
0	0	106	Sheet trash with cultural material	Cut-shell pendant, geometric	*Anodonta californiensis*	1	1	Freshwater	C.1f
0	1	101	Fill of primary extramural feature	Plain bracelet	*Glycymeris* sp.	1	1	Gulf of California / California coast	C.1g
0	3	102	Undifferentiated house fill between floors	Plain bracelet	*Glycymeris* sp.	1	1	Gulf of California / California coast	C.1h
0	3	102	Undifferentiated house fill between floors	Plain bracelet	*Glycymeris* sp.	2	1	Gulf of California / California coast	C.1i
0	1	102	Fill of primary extramural feature	Carved ring-pendant, snake	*Glycymeris* sp.	1	1	Gulf of California / California coast	C.1j
0	1	102	Fill of primary extramural feature	Plain bracelet	*Glycymeris* sp.	1	1	Gulf of California / California coast	–
0	1	102	Fill of primary extramural feature	Plain bracelet	*Glycymeris* sp.	2	1	Gulf of California / California coast	–
Subtotal						*13*	*11*		
Total						16	14		

[a]Minimum number of individuals.

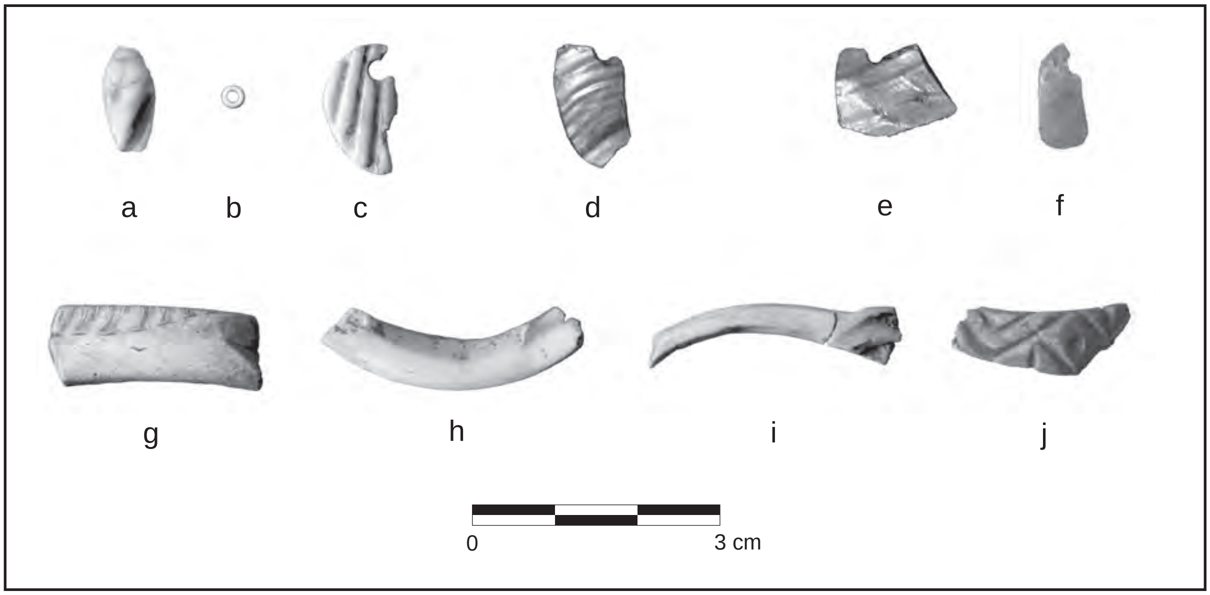

Figure C.1. Shell artifacts from (a) the 3-Up site, LA 150373, and (b–j) the Gamalstad site, LA 164472: (a) whole shell bead, *Olivella dama* (FN 143); (b) disk bead, unidentified marine shell (FN 6); (c) oval cut-shell pendant, *Argopecten circularis* (FN 64); (d) cut-shell geometric pendant, unidentified nacreous, cf. *Anodonta* (FN 101); (e) cut-shell geometric pendant, unidentified nacreous, cf. *Anodonta* (FN 328); (f) cut-shell geometric pendant, *Anodonta californiensis* (FN 378); (g) bracelet fragment, *Glycymeris* sp. (FN 64); (h) bracelet fragment, *Glycymeris* sp. (FN 199); (i) bracelet fragment, *Glycymeris* sp. (FN 199); (j) ring fragment, carved snake motif, *Glycymeris* sp. (FN 88).

APPENDIX D

LABORATORY OF TREE-RING RESEARCH

Ronald Towner

104 W. Stadium
The University of Arizona
Tucson, AZ 85721
5 January 2010

Dear Rob:

This letter constitutes our report on Accession A-1886, the samples from the Three-Up site. Enclosed are the date and species lists.

Unfortunately, none of the samples yielded dates; nine show enough potential that we have accessioned them into our permanent collection.

The species distribution is interesting: 18 juniper spp., 13 ponderosa pine, 6 pinyon pine, and 5 spruce/fir. We often can't tell the difference between spruce and true firs based on the ring structure, but I suspect you have white Fir specimens (we know they are not Douglas-fir).

Sorry for the negative results.

If you have any questions, feel free to contact me at 520-621-6465 or rtowner@ltrr.arizona.edu

Sincerely,

Ronald H. Towner
Associate Research Professor of Dendrochronology

Table D.1. Results of the analysis of tree-ring samples from the 3-Up site, LA 150373.

LTRR No.	Field No.	Species	Provenience	Inside Date	Comment
MIM-828a–b	301-11-1/2	Pinyon pine	Unit 301	No date	Many false
MIM-829	101-9-2/0	Ponderosa pine	Unit 301	No date	Short
MIM-830	101-12-2/5	Ponderosa pine	Unit 301	No date	Short
MIM-831	101-18-2/7	Juniper	Unit 301	No date	Erratic; many false
MIM-832	301-13-2/1	Juniper	Unit 301	No date	Erratic; many false
MIM-833	301-11-1/1	Pinyon pine	Unit 301	No date	Short
MIM-834	301-8-1/1	Juniper	Unit 301	No date	Erratic; many false
MIM-835	101-19-2/8	Juniper	Unit 301	No date	Erratic; many false
MIM-836	301-11-1/3	Juniper	Unit 301	No date	Erratic

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