Technological Analysis of the Formal Chipped Stone Tool Assemblage from Old Town (LA1113) with Obsidian Provenance Studies from Selected Archaeological Sites Throughout the Mimbres Valley

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Abstract

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Throughout the years of 1989 – 2003 excavations were conducted at the Old Town site (LA1113) by Texas A & M University and the University of Texas at Austin. This research represents the first major excavation of a Mimbres site within the lower Mimbres Valley. As part of the overall project, numerous chipped stone artifacts were recovered and collected. The focus of this thesis research is primarily the formal chipped stone tool assemblage, of which the most common artifacts are arrow and dart points. These artifacts were analyzed in a manner outlined by Andrefsky (2001), but particular emphasis was placed on typology, chronology, and raw material acquisition and utilization. The working typology that was utilized for this research was developed by Dockall (1991) for the large recently excavated collection from the NAN Ranch ruin in the middle Mimbres Valley.

The Primary objectives of the research were 1.) to place the formal chipped stone tool assemblage recovered from Old Town within a morphological typology; 2.) to discern patterns within the Mimbreños' technological organization of lithic materials through statistical analyses; 3.) to conduct chemical characterization studies of the obsidian artifacts

recovered from 18 sites located within differing portions of the Mimbres Valley in order to further analyze the apparent patterns within objectives one and two; and 4.) to analyze the ethnographic record for accounts of the social context in which the procurement and distribution of raw materials was enmeshed to aid in the interpretation of the patterns recognized in objectives one, two, and three. The information gained from this research contributes to our understanding of the developments taking place within the Mimbres Valley, and should prove useful in interpreting distributional patterns of lithic materials throughout the archaeological Southwest

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Chapter 1: Introduction

Throughout the years of 1989 – 2003 excavations were conducted at the Old Town site (LA1113) by Texas A & M University and the University of Texas at Austin. This research represents the first major excavation of a Mimbres site within the lower Mimbres Valley. As part of the overall project, numerous chipped stone artifacts were recovered and collected. The focus of this thesis research is primarily the formal chipped stone tool assemblage, of which the most common artifacts are arrow and dart points. These artifacts were analyzed in a manner outlined by Andrefsky (2001), but particular emphasis was placed on typology, chronology, and raw material acquisition and utilization. The working typology that was utilized for this research was developed by Dockall (1991) for the large recently excavated collection from the NAN Ranch ruin in the middle Mimbres Valley.

The primary objectives of the research were (1) to place the formal chipped stone tool assemblage recovered from Old Town within a morphological typology, (2) to discern patterns within the Mimbreños' technological organization of lithic materials through statistical analyses, (3) to conduct chemical characterization studies of the obsidian artifacts recovered from 18 sites located within differing portions of the Mimbres Valley in order to further analyze the apparent patterns within objectives one and two, and (4) to analyze the ethnographic record for accounts of the social context in which the procurement and distribution of raw materials was enmeshed to aid in the interpretation of the patterns recognized in objectives one, two, and three. The information gained from this research contributes to our understanding of the developments taking place within the Mimbres Valley, and should prove useful in interpreting distributional patterns of lithic materials throughout the archaeological Southwest.

Archaeology in the southwestern United States has a relatively long history. Beginning in the mid-nineteenth century with the U.S. Army's surveys of the newly acquired Western territory, and continuing until the present day, the region has proven to be captivating to generations of archaeologists interested in studying the ancestral cultures of the Native American groups inhabiting the region (Cordell 1997). From this captivation came the recognition of unique artifact assemblages and inferred behavioral patterns that resulted in the classification of various prehistoric cultures and the development of corresponding historical sequences. One of these recognized cultures, the Mogollon, has had a somewhat problematic history in regards to its classification. A plethora of interpretations of the Mogollon concept have been postulated: some believed that the culture was a regional variant of its Anasazi neighbors to the north, some believed that the Mogollon were an agglomeration of both Anasazi and Hohokam traits, but most agreed that one main aspect of material culture that would come to define these people as independent from either the Hohokam or Anasazi were the "bold" ceramic designs on what would come to be called Classic Mimbres pottery (Roberts 1937; Kidder in Cosgrove and Cosgrove 1932) (see Figure 1 for a depiction of these culture areas).

Ever since Fewkes' 1914 publication describing his visit to the area for the purpose of examining pottery specimens and conducting an initial reconnaissance of the archaeological remains in the area, ceramics have, for the most part, been the technology that has received the majority of archaeologists' attention within the region (Fewkes 1989).

The study of lithic technology in the Southwest has been greatly overshadowed by that of ceramic technology. While these studies have in some cases increased our knowledge of the social processes involved in the production, distribution, and consumption of ceramic vessels, the idea that different processes could be at work with different cultural materials' technological organization has received considerably less attention. While there are pertinent arguments for why this is so, the analyses of lithic assemblages beyond the study of the end products of production has increased, and more individuals are beginning to incorporate these findings into processes occurring at multiple scales (e.g. Cameron 2001, Peterson et. al. 1997, Adams 1993). Still, however, extensive studies concerning the lithic technology of the Mimbres Mogollon are few and far between. Early studies of Mimbres sites (i.e. Bradfield 1929, Cosgrove and Cosgrove 1932, and Haury 1936) provided little more than descriptive accounts of the end products of stone tool manufacture, and while useful as a heuristic tool, these descriptions tell us little about the people who manufactured, used, and discarded stone tools. More recent literature concerning

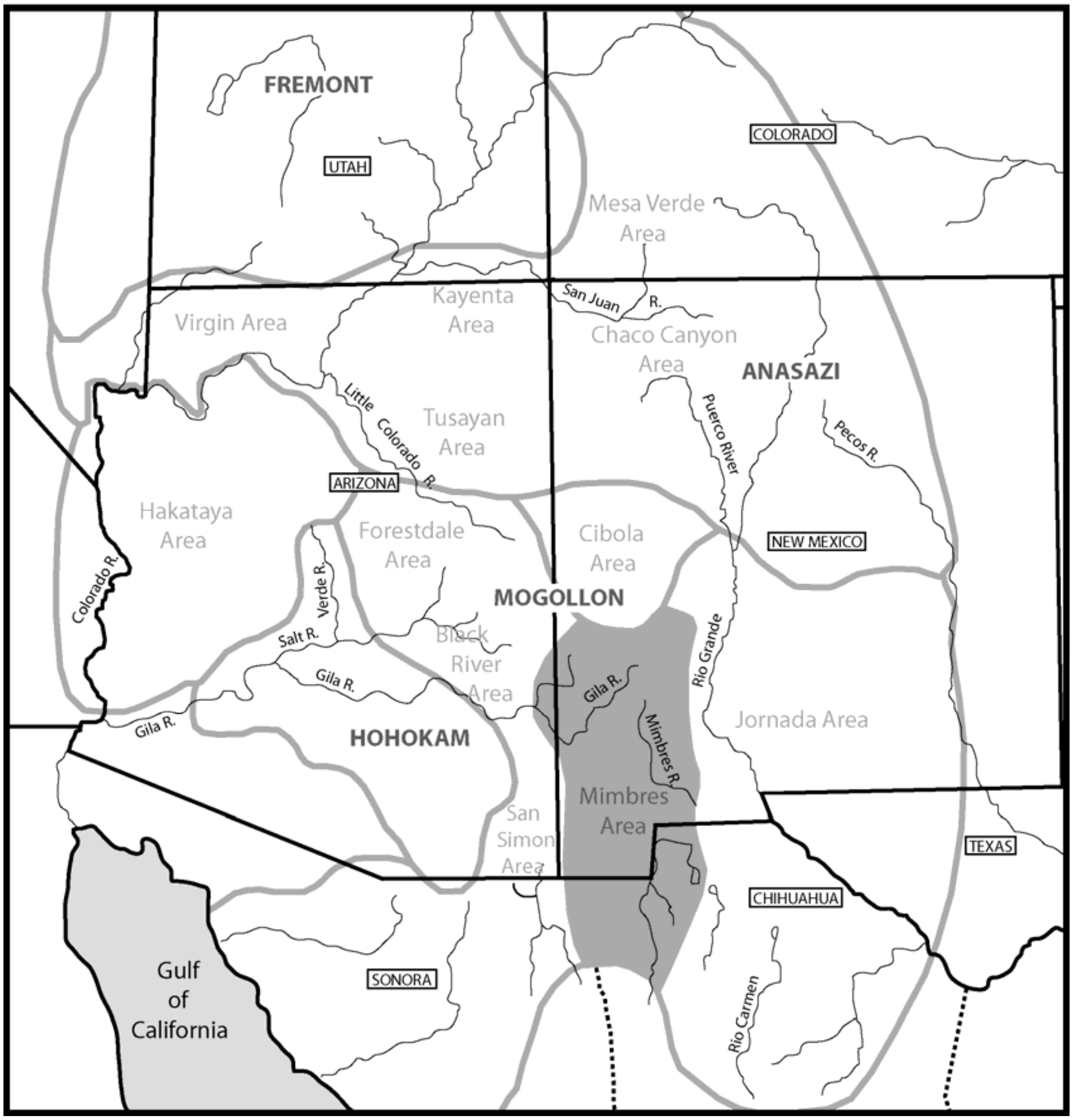


Figure 1: Map depicting the different prehistoric cultural areas within the southwestern United States (after Jennings in Fewkes 1989).

the Mimbres Mogollon has stepped beyond this normative approach and has begun to use information on lithic artifacts to make inferences about social mechanisms operating within the Mimbreños' society (i.e. Nelson 1984, 1986; Dockall 1991; LeBlanc 2001).

Chapter II: Mimbres Archaeology

Mimbres Cultural Chronology

The cultural chronology for the Mimbres Mogollon is traditionally divided into periods and phases. The division between periods is based on differences in material culture and the internal division of periods into phases is likewise based on differences in artifact assemblages. Absolute date ranges are assigned to these periods by cross-dating of diagnostic artifacts, dendrochronology, archaeomagnetic dating, radiocarbon dating, and to a lesser extent obsidian hydration. The following overview is what most would agree to as the likely sequence of events within the Mimbres Valley and is primarily taken from Anyon et al. 1981, Lekson 1992, and Hegmon et al. 1999.

The Paleo-Indian and Archaic periods within the Mimbres Valley are probably the most poorly understood within the sequence. This is due both to the lack of investigation of sites dating to this time period and to preservation issues associated with the great time depth of these periods. The Paleo-Indian period dates from 10,000 B.C. to 6,000 B.C., and the Archaic period dates from about 6,000 B.C. to around A.D. 200. Most of what is known of these periods comes from cross-dating projectile point styles found in the Mimbres area to dated specimens found elsewhere in the Southwest (Lekson 1992). The Late Archaic, or aceramic, pithouse sites have been the most studied within this immense time range, and this is in part due to the presence of circular pithouses during this time. Because these preserve better in the archaeological record, where the earlier ephemeral dwellings leave little if any noticeable trace of habitation, they have received more attention. Aceramic pithouse sites have been found in various portions of Arizona and New Mexico, and are generally located along river terraces. These sites date from 400 B.C. to around A.D. 200, but as Lekson (1992) notes "simply because a site lacks ceramics does not automatically consign it to the Archaic" (1992: 66). These aceramic sites could be the result later non-ceramic producing populations, or could represent non-ceramic components of Pithouse and Classic period land use strategies (Lekson 1992:66).

The Early Pithouse period dates from A.D. 200 to 550 and is a relatively poorly understood period due in large part to less investigation. The dates associated with this period are based solely on a few carbon-14 dates that range from A.D. 130 to A.D. 645 (Lekson 1992: 66-74). This period is marked ceramically by the development of Alma Plain brownware pottery and thinly slipped redwares. This period is also marked by a shift in subsistence strategies from one dominated by a hunting and gathering life-way to one with a greater dependence on agriculture. The settlement pattern of the Early Pithouse period saw the introduction of the pithouse village (Anyon et. al 1981). These villages vary in size and are generally located on higher, usually isolated landforms above the valley floodplain (Stuart and Gauthier 1981: 179). Lekson (1992) notes that this settlement pattern might not be the only one in existence within the Mimbres area.

He shows that Early Pithouse villages within the Reserve and Eastern Mimbres areas are not located in what would have previously been called “defensible positions,” but that the pattern within these areas more closely mirrors the pattern associated with the Late Pithouse and Classic periods within the Mimbres area, in that these villages are located in low lying areas along floodplains (Lekson 1992:73-74). Lekson notes that our conflation of Early Pithouse components with non-decorated ceramics leads to the possibility that any Early Pithouse structure along the lower terraces of the Mimbres River would be misinterpreted due to the occupational histories of Mimbres sites that develop in succession, one component on top of another.

House floor plans of this period are non-rectangular and vary from circular to “bean” shaped, and most possess a lateral entryway (Diehl and LeBlanc 2001:18-21). Early Pithouse period ceremonial structures were also round with lateral entryways and possessed “lobes,” or curved wall portions that extended outward past the end of the entryway and re-curved back to join the entryway to the structure. Other than their larger size, these wall protrusions are the only specialized architectural features that serve to distinguish ceremonial structures from domestic structures during the Early Pithouse period (Anyon and LeBlanc 1980).

The Late Pithouse period dates from A.D. 550 to 1000 and is usually subdivided into the Georgetown, San Francisco, and Three Circle phases. Lekson

(1992) notes that the Early Pithouse period and the Georgetown phase of the Late Pithouse period are often confused because the only diagnostic difference is the quality of the redware pottery present at the site, a determination that is often a subjective interpretation on the part of the archaeologist. This, coupled by the fact that there is no secure evidence for a pre 700 date for the introduction of decorated ceramics into the area, leads Lekson (1992: 80) to posit a starting date of A.D. 700 for the beginning of the Late Pithouse period. The period is differentiated from the Early Pithouse period by shifts in architecture, ceramics, and settlement patterns, with one of the major shifts being the relocation of settlements from the higher elevations down to the terraces overlooking the river floodplain.

The Georgetown phase of the Late Pithouse period dates from the end of the Early Pithouse period to around A.D. 700. Ceramically, this phase is marked by the introduction of San Francisco Red pottery. Sites are usually located along the first terrace above streams or near springs and houses vary from round to “D” shaped. Communal structures of the Georgetown phase retained the overall shape of their Late Pithouse period predecessors but “became considerably larger than domestic pit-structures” (Anyon and LeBlanc 1980).

The San Francisco phase dates from A.D. 700 to around 825/850 and is marked ceramically by the introduction of Mogollon Red-on-brown pottery. San Francisco sites are generally located on the first terrace above rivers, although some settlements were established along tributaries of the Mimbres and Gila Rivers

(Anyon et. al. 1981). House floor plans of this phase range from rectangular with rounded edges to trapezoidal. As was the case previously, some sites are located near springs in areas of considerable distance from the main valleys. While there are changes in the morphology of domestic structures during this phase, ceremonial structures retain their basic shape but continue to grow in size.

The Three Circle Phase dates from A.D. 825/850 to 1000 and is marked first by the manufacture of first Three Circle Red-on-white and then Mimbres Black-on-white Styles I and II. The rectangular pithouses have sharp corners as opposed to the rounded corners of the preceding San Francisco phase. The previously established larger villages continue to be occupied, particularly along the first river terrace, as do those near springs, but new communities are established within "marginalized" environments and along side drainages (Anyon et. al. 1981; Diehl and Leblanc 2001: 22; Pyne 2004: 13). During the Three Circle phase, Hohokam materials begin to filter into the material culture repertoire of the Mimbres people. This is evident in the occurrence of shell ornaments, stone palettes, stone bowls, and ceramics with Hohokam design attributes being found at Late Three Circle phase sites (Shafer 2003). Some researchers believe that the appearance of these Hohokam inspired items is due in part to the substantial presence of Mogollon communities in the Gila River valley living in close proximity to Hohokam groups further downstream. The interactions between these two groups and between the

Gila Mimbres groups and those inhabiting the Mimbres Valley led to the occurrence of Hohokam-esque artifacts at Mimbres Valley sites (Shafer 2003).

The Classic Mimbres period dates from A.D. 1000 to 1150 and is marked by the transition from pithouse architecture to above ground cobble-walled roomblocks that, in some cases, incorporate kivas. Classic period pueblos range in size from one or two rooms to upwards of about 200 arranged in multiple room blocks (Stuart and Gauthier 1981: 199). These Classic period pueblos are often built on top of structures from earlier periods, and while some scholars believe that they emerged in a manner similar to unit pueblos in the Anasazi areas to the north (Lekson 1988, 1992), little evidence of these transitional features have been found in the Mimbres area (i.e. Shafer and Taylor 1986, Shafer 2003). During this period, the large pueblos within the Mimbres Valley grew from core roomblocks that numbered four or five units (LeBlanc 1983; Lekson 1992:15). New pueblos emerged within the Mimbres River's secondary drainages and within upland parklands (Lekson 1992: 15). The presence of Mimbres Black-on-white Style III pottery also marks the beginning of this period, and the exchange of this commodity, as well as the exchange of exotic materials, is characteristic of the increased socio-political interactions taking place during the Classic Mimbres period.

In recent studies dealing with time-space systematics, various researchers have noted the necessity to look at developments taking place within different regions rather than placing these regions within the larger historical sequence

(Hegmon et. al. 1999, Nelson 1999, Hegmon 2002). The majority of these arguments center on the developments taking place within different parts of what has commonly been referred to as the Mimbres area. Specifically they center on the events taking place within these different sub-regions at about A.D. 1130, when the "regional unity of the Late Pithouse and Classic periods began to break down" (Hegmon et. al. 1999:143). During this time, continuity within the region collapses, and two distinct traditions develop within the eastern and western Mimbres areas.

Most researchers find it useful to split the area that had traditionally been termed the Mimbres area into an eastern Mimbres area that denotes settlements along the Rio Grande drainages, and the Mimbres valley. Within the eastern Mimbres area, the developments of post A.D. 1130 are termed Postclassic Mimbres, and refer to the settlement shifts that occurred within the region. During this time within the eastern Mimbres area, some of the larger settlements are abandoned, and new settlements emerge at some of the former locations of agricultural field houses, producing a much more dispersed settlement pattern than that of the preceding Classic period (Hegmon et al. 1999, Nelson 1999, Hegmon 2002). Classic Mimbres Style III and Mimbres Corrugated pottery were still used in the Postclassic, but other ceramics enter the area (i.e. Playas Red Incised, El Paso Polychrome, Tularosa Black-on-white, Tularosa Patterned Corrugated, and St. John's Polychrome), some of which were made locally (Hegmon et. al. 1999: 156). As Nelson (1999) notes, abandonment does not mark the end of a culture and while the population of the Eastern Mimbres area dispersed from the aggregates of the Classic period, not everyone reestablished themselves within the emergent coursed adobe structures of the Black Mountain phase. Some opted to stay within the valleys of the Eastern Mimbres area but reorganized their use of the landscape by reverting back to social adaptations that had been in place there during the Pithouse periods, namely dispersal as opposed to aggregation.

Within the Mimbres Valley area, the developments taking place after A.D. 1130 have been labeled Terminal Classic Mimbres and refer to developments taking place at Classic Mimbres villages within the middle and southern Mimbres Valley after A.D. 1130, which are distinguished by the introduction of El Paso Polychrome, Playas Red Incised, Chupadero Black-on-white, Tularosa Patterned Corrugated, and Chihuahan Corrugated pottery (Hegmon et al. 1999: 154). These new ceramic styles indicate that the inhabitants of Terminal Classic settlements were expanding their social networks, while at the same time continuing the life ways of the preceding Classic period (Hegmon et al. 1999).

During the Terminal Classic of the Mimbres Valley area, sometime around A.D. 1130-1150, during a drought, Classic Period villages above 6000 ft. were abandoned; but those at lower elevations continued to be occupied. New settlements begin to be established within the lower Mimbres valley and some interpret these settlement changes as the cultural collapse of the Mimbres Mogollon social order, and the assimilation of the once existing social system into the Casas Grandes interaction sphere to the south (LeBlanc 1989).

New interpretations, however, hold that continuity exists between the Classic period peoples and those of the succeeding Black Mountain phase (A.D. 1150-1300) peoples as is evident by new data concerning ceramic assemblages, settlement patterns, mortuary patterns, and subsistence strategies. Creel (1999a) shows that these new ceramics (El Paso Bichrome and Polychrome, Chupadero Black-on-White, Playas Red series, White Mountain Red Ware, and Reserve area ceramic types) were in fact not only found in Terminal Classic contexts but that some were actually being produced within the Mimbres Valley. Creel also shows that while some of these painted ceramics were in fact not imported, the corrugated utilitarian wares show only modest changes from the Classic period to the Black Mountain phase. The presence of Black Mountain phase ceramics at Classic period pueblos such as Old Town suggests that certain Classic period inhabitants could have possibly continued their life ways during Terminal Classic through to the Black Mountain phase. In addition, evidence from a few pueblos suggests an even more Mimbres-like form of continuity with the construction of small "post-Mimbres" like adobe structures on top of earlier Classic period pueblos (Lekson 1992: 20).

The mortuary patterns of the Classic period also show continuity of Classic period cultural traits into the Black Mountain phase. The predominant Classic period pattern of subfloor inhumation of deceased individuals buried with a killed ceramic vessel placed over their head is also dominant in Black Mountain phase contexts. The other mortuary pattern present in the Classic period was that of cremation. In most cremations, the individual's cremated remains were placed within a jar, which was then covered with a killed bowl. These remains were then placed within a subfloor pit. This pattern was also practiced during the Black Mountain phase (Lekson 1992). Thus there is substantial evidence for continuity between the Classic period, Terminal Classic, and Black Mountain phase peoples.

As noted previously, during the Black Mountain phase, populations from at higher elevation Classic sites abandoned their settlements and established larger villages, averaging 125 rooms, within the lower elevation desert environments. Some of these settlements represent new communities in previously unoccupied locations, but new room blocks are constructed in close proximity to Classic period and Terminal Classic structures. There is a shift from the cobble-walled architecture of the Classic period to U-shaped adobe pueblos, and Black Mountain Phase ceramics replaced the local Mimbres ceramics produced during the preceding periods.

According to Hegmon et al. (1999), the Black Mountain phase within the eastern Mimbres area dates from the end of the Postclassic (ca. A.D. 1250) and continues up into the 1400s. Surveys revealed that the northern most extension of the Black Mountain phase within the eastern Mimbres area was along Seco Creek, a western tributary the Rio Grande (Hegmon et al. 1999). Excavations at one of the Black Mountain phase sites (Las Animas Village) revealed a pattern similar to that of the western Mimbres area in that the village was built on top of an earlier Classic period village (Hegmon et al. 1999).

The Cliff / Salado period dates from A.D. 1300 to 1450 and is characterized by the introduction of Salado polychrome (i.e. Gila, Tonto, and Pinto Polychrome) pottery into the Mimbres Valley. This period is also marked by the occurrence of Chihuahuan polychrome and Playas-like redwares within the Mimbres area. Late El Paso Polychrome and Chupadero Black-on-white ceramics occur at sites during this period and suggest continuity between Black Mountain phase peoples and those occupying Cliff phase settlements. Cliff phase settlements occur at most elevations (i.e. the upper, middle, and lower valley) and are found along main valleys within the Mimbres areas. Sites from this period "generally take the form of compounds enclosing pueblo-type rooms," and these sites exhibit either adobe pueblo architecture or a combination of cobble-walled and adobe architecture depending on the location of the site (Stuart and Gauthier 1981: 208). Nelson and LeBlanc (1986) believe that these structures were built by groups of mobile agriculturalists who erected structures rapidly, occupied them for a short period of time, leaving little if any traces of trash accumulation and room remodeling, and then abandoned the site, moving to different areas.

History of Archaeological Investigations within the Mimbres Area

The history of archaeological investigations within the Mimbres area dates back to the first decades of the 20th century. Researchers became interested in the area after Kidder's work at Pecos Pueblo had began and which culminated with the now famous Pecos Classification System. This research, which focused primarily on ceramic and architectural data, was to lay the ground work for not only the interest in the Mimbres Mogollon but was also partly responsible for the initial lumping of this cultural group into both Anasazi and Hohokam cultural units. As interest in ceramics grew, so did the recognition that unique ceramics were present within the Mimbres area; and this recognition eventually lead to the Smithsonian Institution's senior ethnologist Jesse Walter Fewkes to obtain samples from private collectors for the Museum's collection. While visiting the area, Fewkes conducted a partial survey as well as limited testing of particular sites within the area to assess the valley's archaeological remains. Fewkes left the valley with a substantial collection of whole vessels somewhat unconsciously spurring both the museums collectors to follow suit as well as spurring the pot hunters within the area to amass collections for museums that were willing to pay top dollar for exquisite specimens. Another problem presented itself before the researchers analyzing the recently acquired material: who were the people who manufactured these ceramics?

This problem confounded researchers interested in the area for two decades. As stated earlier, this culture area was variously interpreted as either primarily influenced by the Hohokam to the west or the Anasazi to the north with varying amounts of dissolution or saturation from the other (Roberts 1937, Rinaldo 1941, Reed 1942). While early excavations at the Galaz, Mattocks, Swarts, and Cameron Creek ruins were contributing to the knowledge of prehistoric developments within the area, it wasn't until Haury's work at the Mogollon Village and Harris Village sites that the Mogollon culture came to be seen as independent from both the Hohokam and Anasazi cultures (Anyon and LeBlanc 1984; Bradfield 1929; Cosgrove and Cosgrove 1932; Haury 1936; LeBlanc 1975, 1983). This interpretation was based primarily on architectural variation between the different areas during the Early Pithouse period within the Mimbres Mogollon region. While there was some debate after Haury's work within the area as to the taxonomic status of the Mogollon culture, its foothold was strong.

After Haury's 1936 publication, researchers continued to visit the area with their primary objective being to work out the chronological sequence and the identification of artifacts associated with its divisions. This time period within Mogollon archaeology coincided with a period in archaeology's epistemological history that was dominated by what has been termed the "normative" approach, and the critiques leveled on this approach by the pioneers of what would come to be termed the “new archaeology” (i.e. Taylor 1967, Binford 1972), were to lead the next group of archaeologists to enter the region.

In 1974, excavations began at the McAnally site, the Mitchell site, the Mattocks site, the Janss site, and LA 12109 (LeBlanc 1975). The work was being conducted by the Mimbres Foundation, a group of graduate students under the guidance of Steven LeBlanc, whose primary objective was to study the cultural remains of the Mimbreños before looters had completely obliterated many of the sites within the valley. LeBlanc was interested in testing at least one site from each of the Mimbres Mogollon’s chronological phases, a goal which was for the most part met (Gilman 2004 personal communication). After the 1974 field season, plans were made to conduct a survey of the Mimbres Valley and associated drainages during the 1975 field season. From 1975 to 1977 a series of surveys were carried out and covered a total area of 10,014 hectares. These surveys located 30 Early Pithouse period sites, 27 Late Pithouse period sites, 69 Classic period sites, and numerous other sites lacking architectural features (Blake et al. 1986). The years during which these surveys were being conducted also saw the testing of numerous sites that represented samples from each of the divisions within the newly emerging historical sequence of the Mimbres Valley (Anyon and LeBlanc 1984; LeBlanc 1975, 1976, 1977, 1983; Nelson and LeBlanc 1986). The publications that resulted from the work of the Mimbres Foundation (e.g. LeBlanc 1975, 1976, 1977, 1983; Anyon and LeBlanc 1984; Minnis 1985; Nelson and LeBlanc 1986) have resulted in a greater understanding of the variability within the Mimbres Mogollon cultural tradition and have served as spring boards for an efflorescence of studies during the past two decades that have addressed a broad range of social issues including social organization (i.e. Lightfoot and Feinman 1982, Gilman 1990), subsistence strategies (i.e. Stokes and Roth 1999; Diehl 1997, 1996; Nelson 1993), and mortuary practices (i.e. Gilman 1990, Creel 1989). The work of the Mimbres foundation has also guided the excavations of sites within the Mimbres and adjacent areas (i.e. Lekson 1990, Nelson 1999, Shafer 2003, Creel 2004).

Chapter III: Physical location and environment

Since topography and climate are to some extent interdependent, when one changes so does the other. Precipitation within the area occurs in a bimodal distribution with "cyclonic" storms occurring mainly in February and more sporadic, localized events occurring form July through September (Minnis 1985: 71). The frost-free period also differs with elevation with portions of the lower valley having a frost-free period of about 220 days, and higher elevations along the Mogollon Highlands having a period lasting about 120 days (Minnis 1985: 73). Cordell (1997) adds little to Minnis's characterization of the region. She also places it within the Basin and Range physiographic province that is characterized by a single cyclonic rainfall pattern that occurs in the summer and areas of higher elevation obtain added moisture as a result of orographic precipitation.

Through his work with the Mimbres Foundation from 1974 to 1980, Paul Minnis came to recognize the variation within the environment and divided the area surrounding the Mimbres Valley into two topographic zones. These zones, a desert zone and a mountain zone, varied with elevation, and thus represented differing environments. Since the Desert zone consists of areas with a base elevation of 1200m, the zone usually corresponds with the Lower Chihuahuan Vegetal Zone, which is characterized by ephemeral stream flow and is dominated by "desert scrubs and strands of grass" (Minnis 1985: 78). Stream floodplains are often populated by "desert willow, rabbit brush, desert hackberry, mesquite, and cottonwood" (Minnis 1985: 78). The Upper Chihuahuan Vegetal Zone represents a somewhat transitional zone between the Desert and Mountain Topographic zones. The areas placed within this category are populated by oak and pinion / juniper woodlands intermixed with a variety of desert shrubs. The floodplains of this vegetal zone are populated by "cottonwood with alder, elder, ash, walnut, and willow with an understory of ragweed, sunflower, pigweed, grasses, and goosefoot" (Minnis 1985: 80). The final vegetal zone recognized by Minnis is the Transitional Zone, which is located within the 2135m to 2750m elevation band. This zone is similar to the Upper Chihuahuan Zone but is located at higher elevations and is characterized by ponderosa pine, oak, spruce, fir, and juniper canopies and an understory consisting of grasses (Minnis 1985: 80-81).

For the most part, Minnis's characterization of the region has been the most utilized, and while some scholars feel obliged to change the syntax (i.e. Lekson 1992), the basic order of upper, middle, and lower zones that change with respect to elevation is a proper way to partition the region. Diehl and LeBlanc (2001) uphold the basic structure of this model but feel it heuristically useful to split Minnis's and Lekson's groupings of the region. In their model, the area is divided into a subalpine forest zone, a montane conifer forest zone, a Great Basin conifer woodland zone, a Madrean evergreen woodland zone, a Plains Grassland zone, a semi-desert grassland zone, and a Chihuahuan desert scrub zone (Diehl and LeBlanc 2001: 12-17).

The Subalpine Forest zone, located between 2450 – 3500 meters in elevation, receives around 635 to 1000 mm of precipitation per year and has a frost-free period of approximately 75 days. The species that dominate the canopy include varieties of alder, aspen, birch, cottonwood, fir, madrone, maple, oak, pine, poplar, spruce, and willow, while the understory contains numerous species of edible plants. Various animal populations including bears, mountain sheep, mule deer, and elk inhabit this vegetal zone (Diehl and LeBlanc 2001:13).

The Montane Conifer Forest biotic zone, located between the 2300 – 3000 meter elevation band, typically receives more than 500mm of precipitation per year. The species that dominate the canopy include Ponderosa pine, alligator-bark juniper, Gambel oak, and other species of oak, while the understory contains sumacs, currants, and other edible plants in the moister areas. Numerous animal populations inhabit the biotic province and include elk, mule deer, white-tailed deer, and mountain sheep (Diehl and LeBlanc 2001: 14).

The Great Basin Conifer Woodland province, commonly referred to as the "pinion-juniper" zone, is located between 1500 – 2300 meters in elevation and receives between 300 to 500mm of precipitation annually. Ponderosa pine and alligator-bark juniper occur occasional, but the province is dominated by pinion pine and one-seed juniper with cottonwood occurring along the floodplain of the Mimbres River. There are numerous fruit producing cacti and shrubs in the zone, and all animals present at higher elevations are present in this zone except for mountain sheep (Diehl and LeBlanc 2001: 14).

The Madrean Evergreen Woodland zone is dominated by a variety of oaks and pines, one-seed juniper, and pinion pine with cacti and other fruit-producing shrub present as well. Numerous animals are found in this zone but the large mammals within the zone are limited to bear and deer (Diehl and LeBlanc 2001: 14).

The Plains Grassland biotic zone is the southwestern most extension of the shortgrass prairie of the western Great Plains. This physiographic zone receives around 250 to 300 mm of precipitation annually with the majority falling between the months of June and August. Mammals that commonly inhabit the area include elk, mule deer, pronghorn antelope, and possibly bison (Diehl and LeBlanc 2001: 14-15).

The Semi-desert Grassland province, located between the 1600 and 1800m elevation zone, receives about 250mm of precipitation annually. This province includes the modern grass and shrub infested zones populated by creosote bush, Mormon tea, rabbit brush, and saltbush that flourish as a result of overgrazing, as well as strands of cottonwood, mesquite, oak and walnut along the floodplain of the Mimbres River. Animal populations that inhabit the area include elk, mule deer, antelope, coyotes, jackrabbits and the occasional mountain lion. Diehl and LeBlanc (2001) believe that access to this biotic zone could be one of the contributing factors creating the differences between the Mountain and Desert Mogollon (2001: 15).

The physical landscape of the Chihauhuan Desertscrub biotic province is dominated by low rolling hills and receives on average between 200 to 300 mm of precipitation annually. Along the floodplain, cottonwood and oak flourish, while away from the drainage, various grasses, brushes and cacti populate the area. Antelope, coyote, jackrabbits, javelinas, roadrunners, various rodents and lizards populate this province (Diehl and LeBlanc 2001: 15-17).

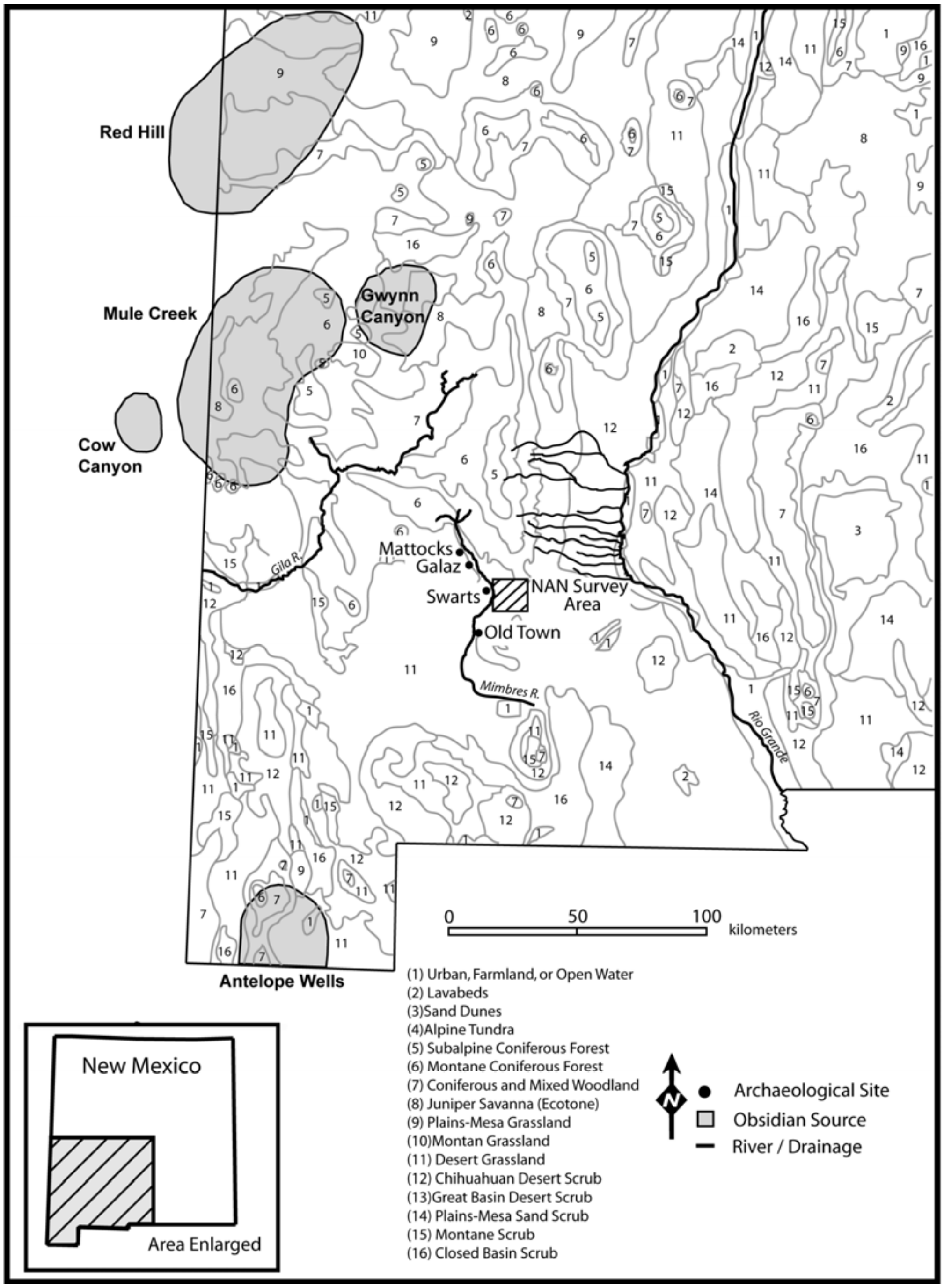


Figure 2: Depiction of biotic provinces in portions of New Mexico, location of obsidian sources, and archaeological sites discussed in text (Information taken from LeBlanc 1975, Shackley 1995, and from New Mexico Resource Geographic Information System Program at the University of New Mexico 2004).

Chapter IV: Overview of sites represented in Typological and Compositional Analyses

The following section presents a brief overview of excavations from which obsidian artifacts were submitted for portions of this study. Material from Old Town, Mattocks, Galaz, Swarts, and sites located during the NAN Ranch Project's survey of Gavilan Canyon were submitted for chemical characterization. Additional material from the Powe site, the Disert site, and three sites located during the Mimbres Foundation's survey of the Mimbres Vally (Z:13:21, Z:13:16, and Z:5:86) was submitted, though no account of the archaeological work conducted at the site or the architectural remains encountered during this work are presented in the following pages.

Old Town Ruin

Old Town is located along a bluff overlooking the southern portions of the Mimbres valley within the semi-desert grassland biotic province. Publications with descriptions with descriptions of the ruin began to appear during the first decade of the twentieth century. Duff (1902), one of the earlier visitors to the site in 1902, noted that site contained at least sixty rooms, this number being visible from the surface. He was also one of the first to publish an account of the burial practices of the Mimbres people (Duff 1902 in Creel 2005). Fewkes was the first professional archaeologists to visit the site and noted that it was one of the "most extensive" seen during his survey of the valley in 1913 (Fewkes 1914: 10). Following on the heels of Fewkes visit to the area, the American Museum of Natural History sent Nels Nelson into the area in 1920 to document the sites from which their purchased pottery specimens had originated. It wasn't until more than a half century later that another archaeologist was to examine the ruin. Excavations at Old Town began in the summer of 1989 as part of the Texas A & M University field school. The years following this initial field season have seen extensive excavations by the University of Texas at Austin (Creel 1991, 1993, 1995, 1997, 1998, 1999).

The site is composed of different habitation areas reflecting most of the stages in the Mimbres Mogollon cultural sequence. Area A consists of a Classic period pueblo with a substantial Pithouse period component lying beneath; Area B is composed of an isolated Late Pithouse period component; Area C consists of a Black Mountain phase pueblo superimposed on top of a Pithouse period component; and Area D consists of a large midden at the base of the bluff that contains refuse from Area A above (Figure 3). As stated earlier, excavations at Old Town began in 1989 with Texas A&M University's field school. During the course of the 1989 field season, investigations were conducted in Area A and centered on unit 1. Unit 1a and Unit 1b, on the east and west side of the bulldozer trench were opened and uncovered the architectural remains of Rooms A1, A2, A3, A4 and A5, all of which were Classic period rooms with the exception of Room A5 which represents a Three Circle phase pitstructure.

In 1990, the Old Town Project shifted to the University of Texas at Austin's field school, whose work concentrated on excavating Room B2 in Unit 4 and testing Room B4 in Unit 5 (Figure 4), both of which are Three Circle phase structures. Area B was again the primary area of interest in 1991, when excavation of Room B4 was completed. The only excursion out of Area B during these two field season came with the testing of Unit 6 in Area A (Figure 5). This Unit was opened because the area appeared to have Classic period remains that showed little evidence of having been disturbed by looters (Creel 1991)

During the 1992 excavations, the majority of the research focused on finishing the excavation of Rooms A2 and A7 in Area A. These two Classic period rooms had first been tested in 1990 and the intensive excavations in Area B during the 1991 field season required that further investigation into these features wait. During the course of excavating Room A7, Room A12, a probable Georgetown phase pit structure was encountered under the floor of Room A7. Also, during this season's excavations, Room A10 in Unit 7 was uncovered (Creel 1992).

In 1993 every area within Old Town experienced testing. In certain cases, like Area B, the object of this testing was to test magnetic anomalies detected by proton magnetometer surveys carried out in Areas A and B. Unit 10 in Area A was excavated to research a series of anomalies detected in the area. In Area B, Units 8, 11, and 12 were also opened to test magnetic anomalies detected by the magnetometer. In addition to work conducted to test the utility of proton

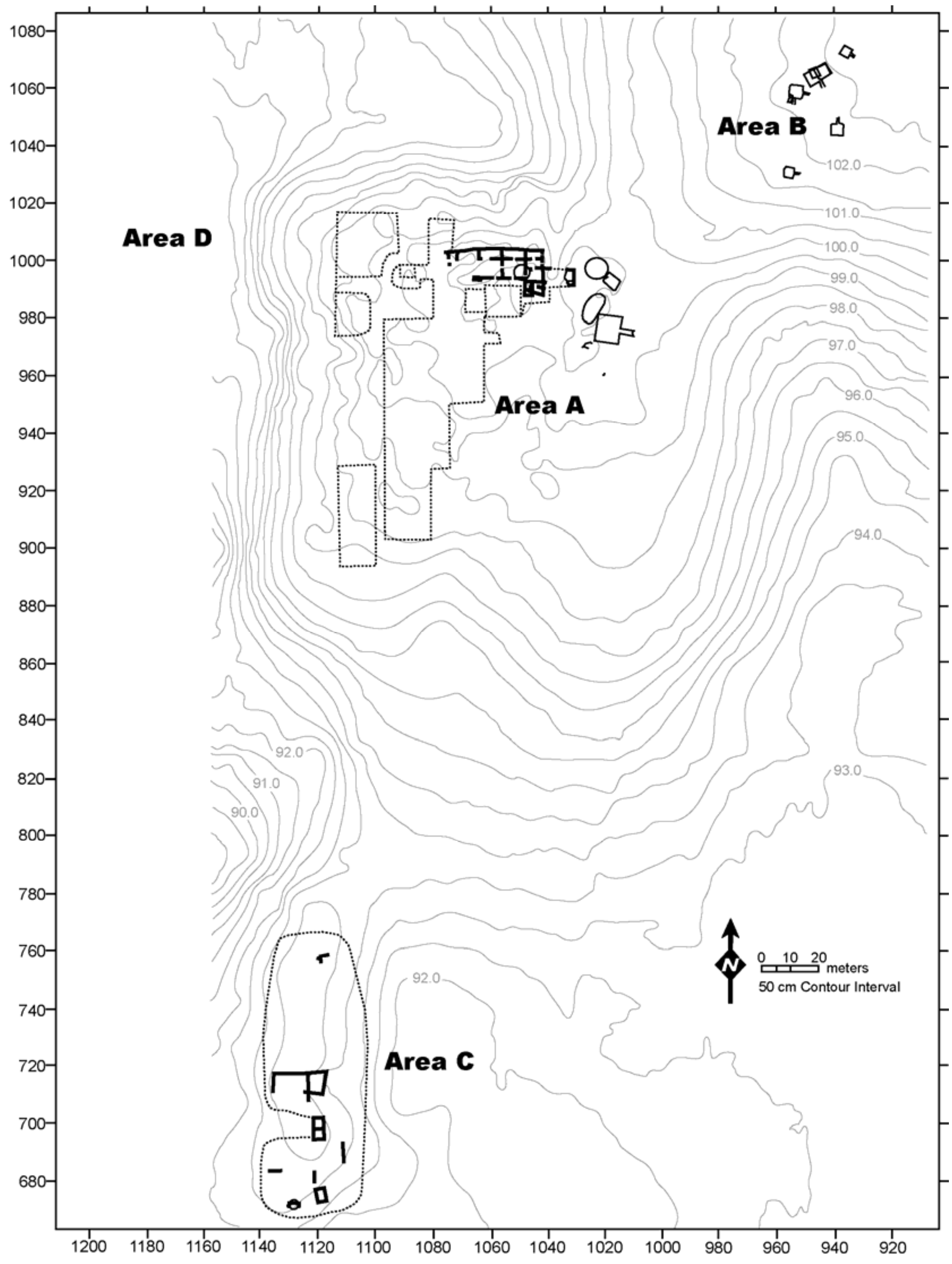


Figure 3: Plan view of Old Town showing the different excavation areas and associated architectural remains.

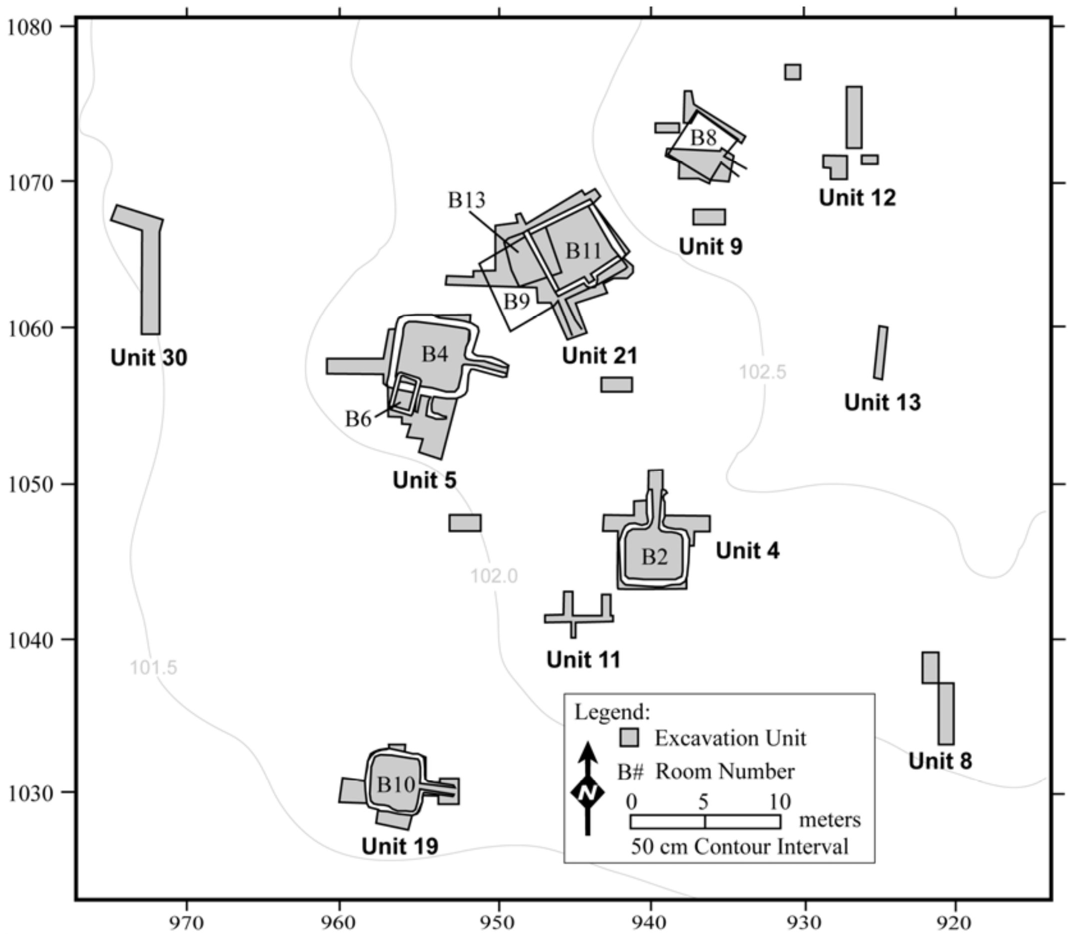


Figure 4: Plan view of the excavation units and architectural remains in Area B at Old Town

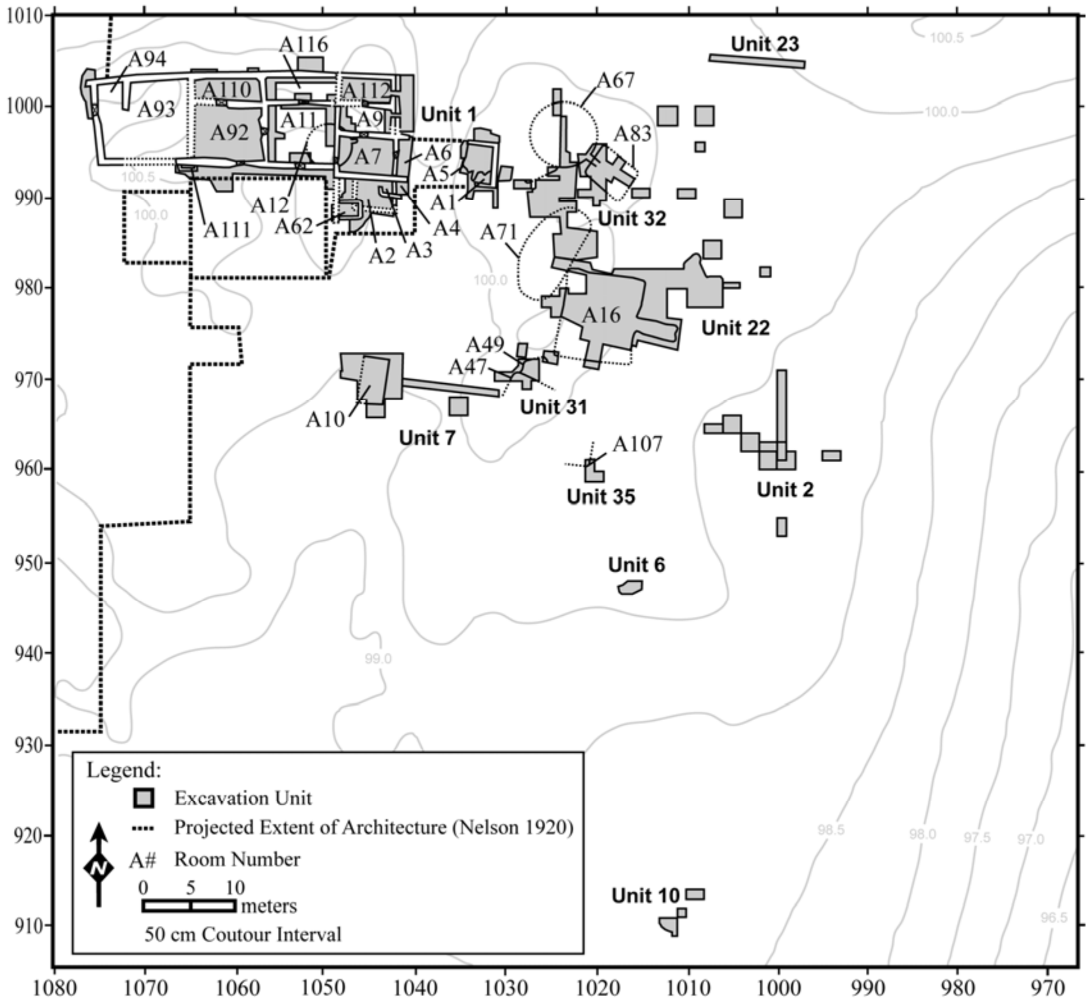


Figure 5: Plan view of the excavation units and architectural remains in Area A at Old Town

magnetometer use at the site, a number of other units were opened during this field season. In Area B, Units 9 and 13 were excavated to test “low mounded areas” (Creel 1993: 3). While Unit 13 was closed off because it failed to yield any significant remains, Unit 9 revealed the presence of a Three Circle phase pitstructure (Room B8). Investigations in Area C (Figure 6) consisted of five units, Units 14, 15, 16, 17, and 18. Unit 14 was opened to expose the Black Mountain phase Rooms C1 and C2 which were visible on the surface. This unit also exposed the presence of Early and Late Pithouse period components at Area C. Unit 16 was opened to also test remains visible on the surface. This unit exposed an almost completely destroyed Black Mountain phase room (C3) with a Georgetown phase pitstructure (Room C4) underneath. Limited investigations at Unit 17 also revealed the presence of another Black Mountain phase room (C8); though only wall trenching was conducted, floor remnants were detected at roughly 15cm below the surface (Creel 1993).

The 1994 excavations at Old Town centered on the continued investigation of Areas B and C as well as new investigations as to the presence of a prehistoric road at the site. In Area B, Units 19 and 21 were opened. These units revealed the presence of Rooms B10 in Unit 19 and Rooms B9, B11, and B13 in Unit 21. Of the rooms excavated within Unit 21, Rooms B9 and B13 are both Three Circle phase domestic pitstructures, and Room B11 is a Three Circle phase communal

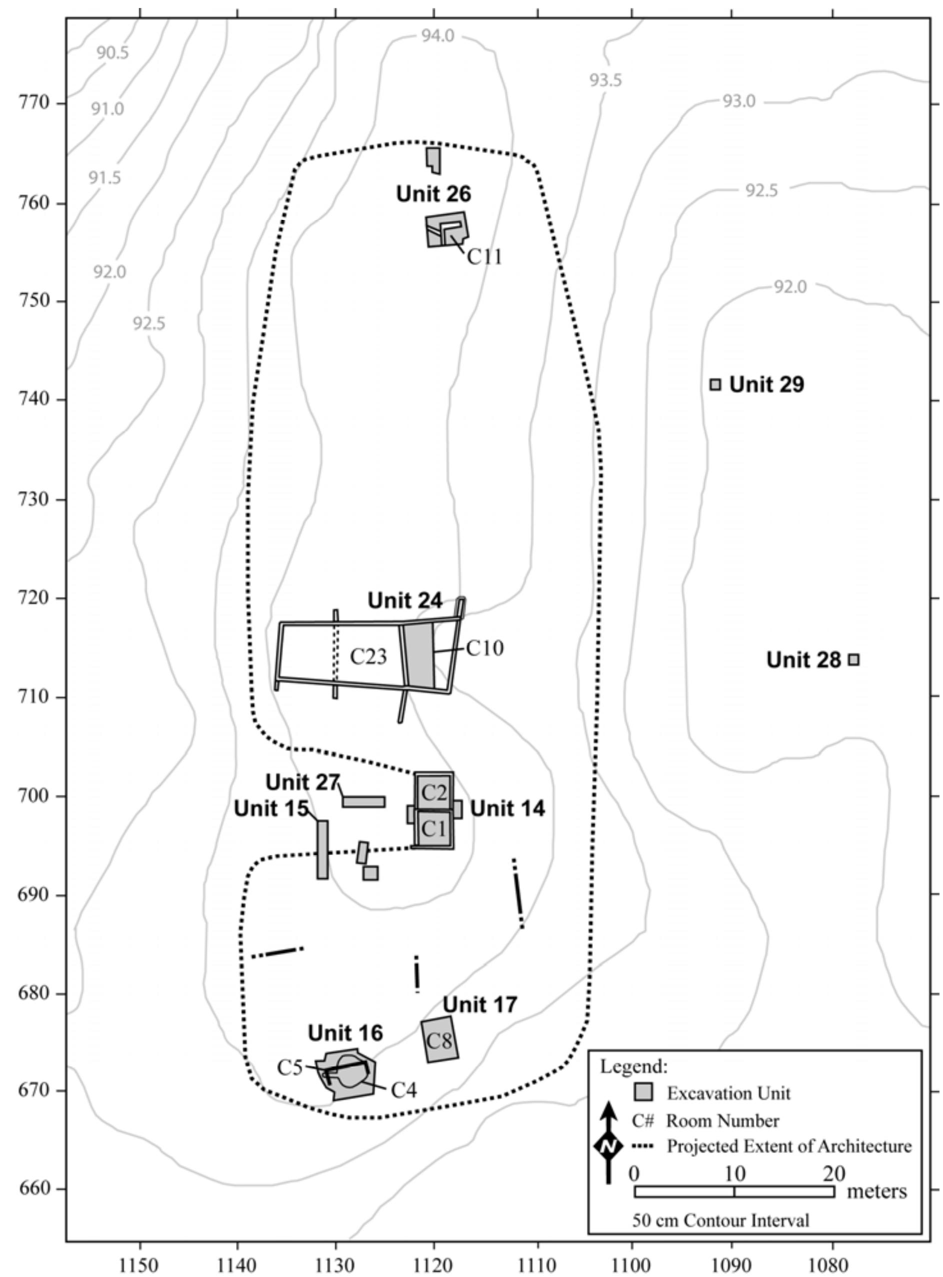


Figure 6: Plan view of the excavation units and architectural remains in Area C at Old Town

pitstructure. Room B10 of Unit 19 is a Three Circle phase domestic pitstructure.

Investigations at Area C centered on the excavation of Units 24, 26, 27, 28, 29. This unit was excavated to investigate the Black Mountain phase Rooms C10 and C23 that were visible from the surface. Though no formal floor surface was found in Room C10, features found beneath a layer of compact soil were indicative of Pithouse period components. Unit 26 was excavated to investigate possible wall remnants visible from the surface. Room C11, a Black Mountain phase room, was encountered during the course of this unit's investigation. In investigating the prehistoric road found at the site by examining aerial photographs, two test trenches, Units 22 and 23, were excavated and revealed the presence of smoothed portions of bedrock "exactly where the aerial photographs show the alignment to be" (Creel 1994: 22). Later investigations into Unit 22 (Creel 1997, 1998) would show the prehistoric road leading to the entryway of Room A16, a Three Circle phase communal pitstructure.

In 1996 the majority of the field season's attention was directed towards the excavation of Room A16, which was initially located within the profile of trench Unit 22. This Unit was expanded substantially to reveal the Three Circle phase communal pitstructure (Room A16). Other excavations took place in Areas B and C that were primarily concerned with defining the structures exposed in previous season's excavations (Creel 1997).

The excavations of the 1997 field season again centered on Area A. Unit 22 continued to be explored and new excavations were conducted in Unit 1 in an effort to locate the southern wall corners of Room A2. During this investigation, Room A62, a Terminal Classic room with a flagstone floor, was revealed. Excavations at Unit 2 were conducted to test the large depression to the southeast of the Classic period roomblocks. This investigation recovered few significant architectural features. Unit 31 was likewise excavated to investigate a depression, and in the process revealed Rooms A47 and A49, two Pithouse period structures. Unit 32 (Figure 7) was excavated to investigate the presence of mounded mass, originally thought to be related to the prehistoric road. These initial investigations into Unit 32 revealed Feature A58, a freestanding wall segment (Creel 1998).

In 1998 the excavations at Old Town centered on Area A and continued the excavations within Units 1, 22, and 32 of the preceding years. Within Unit 32, Rooms A71, A67, and A83 were revealed. Each of these ceremonial pitstructures dates to the Late Pithouse period occupation of the site. Creel and Anyon (2003) note that “Room A67 dates to the A.D. 600s, Room A71 dates to sometime around A.D. 800” and Room A83 dates to the Three Circle phase (Creel 1999; Creel and Anyon 2003:70). These new investigations substantiated the claims that Feature A58 was a freestanding wall segment that was built on top of a platform (Feature A51). These features are believed to be associated with Burial 18 (Feature A52).

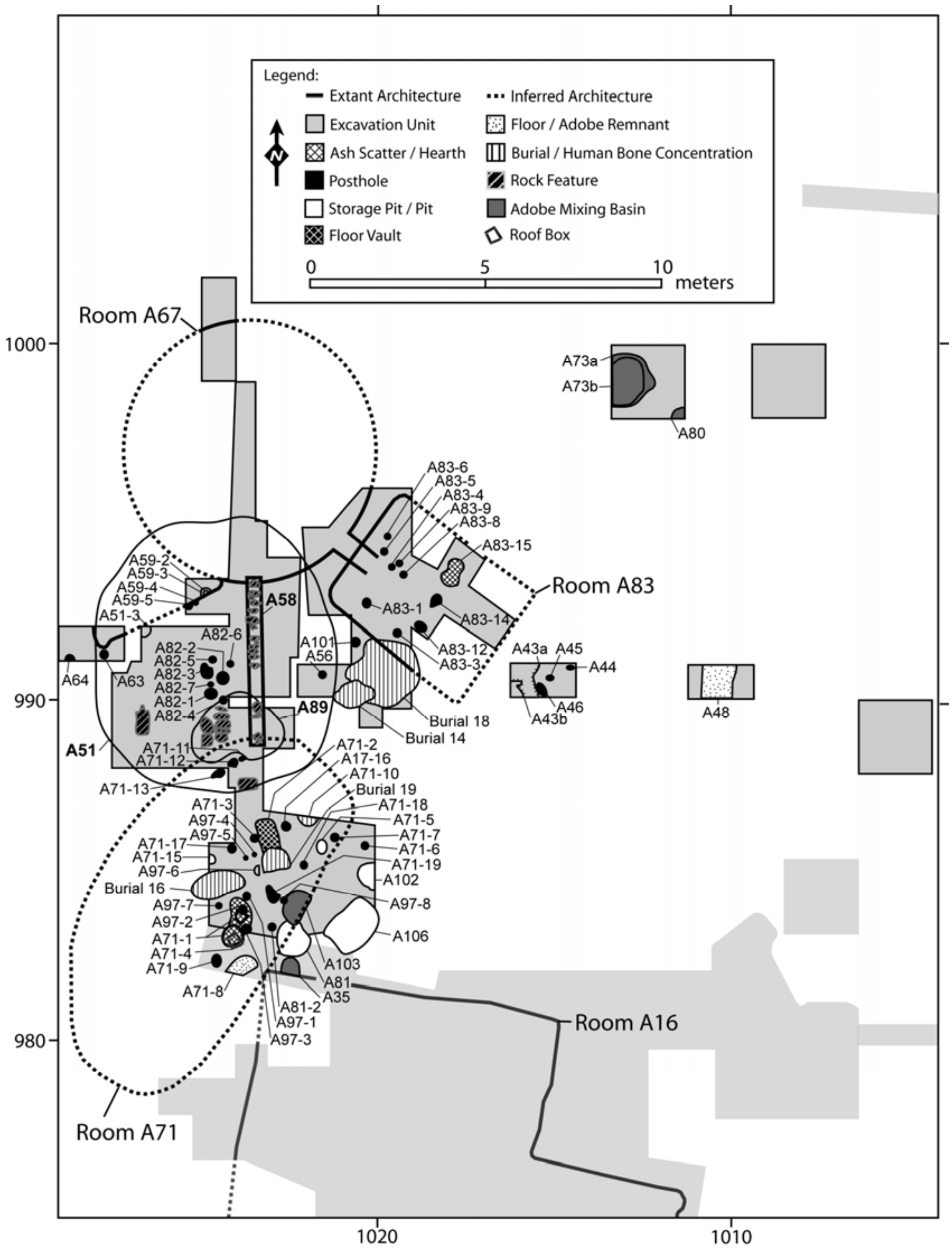


Figure 7: Plan view of Unit 32 and portions of Unit 22 showing the location of exposed features.

This assumption is based on the presence of similar deposits and the absence of intervening deposits between both of these features, suggesting that both events, the construction of A51 and the interment of Burial 18, took place at approximately the same time (Creel 1999; Creel and Anyon 2003). A considerable amount of wall trenching took place within the Classic period pueblo during this field season. As a result of these efforts, the extent of Rooms A9, A112, A11, A16, A92, A110, A93, and A94 were delimited.

Excavations that took place during the 2001 and 2003 field seasons primarily focused on excavating these rooms. Rooms A9, A112, A11, A16, and A92 were completely excavated. During this season additional magnetometer work conducted and the anomalies from this work were tested. Unit 35 was excavated to test a large magnetic anomaly. The southeastern corner of Room A120 was found during this excavation and represents the southeastern corner of the magnetic anomaly. The northwestern corner of this anomaly corresponds with the northwestern corner of Room A47, suggesting that perhaps these two features, A47 and A120, could be one in the same, and that there is another large communal pitstructure south of Room A16 (Creel 2004)

Mattocks Ruin

Early work at the Mattocks ruin was carried out by Paul Nesbitt who excavated approximately 60 rooms in 1931 (LeBlanc 1975). The Mimbres

Foundation's excavations at the site (Figure 8) began in 1974 after an initial reconnaissance of the Mimbres Valley made it clear the there were no undisturbed Classic Mimbres sites within the valley proper (LeBlanc 1983). LeBlanc notes that "it took considerable effort just to identify a site which might provide the kind of information we needed," and the Mattocks site was chosen over the other possible Classic period sites because "it was in better condition than had been imagined" (LeBlanc 1983: 80). The researchers divided the site into room blocks, and these were targeted for the purposes of excavation. In all, four room blocks were tested, some receiving more attention than others, and some, like the 100's room block, yielding undisturbed portions that sometimes consisted of multiple rooms. Extramural areas were also tested during the course of the excavations and revealed not only outside ramada areas but also a possible plaza area between the two largest room blocks (100's room block and 200's room block). Excavations at the Mattocks Ruin revealed that the site had a complex history beginning in the Late Pithouse period and continuing up until the terminal Classic period (ca. 1130-1150). In all around 30 of the estimated 200 rooms were excavated, one kiva was excavated, 80 burials were recovered, and 237 dendrochronology samples were collected from the Mattocks Ruin (LeBlanc 1983, Gilman 1990).

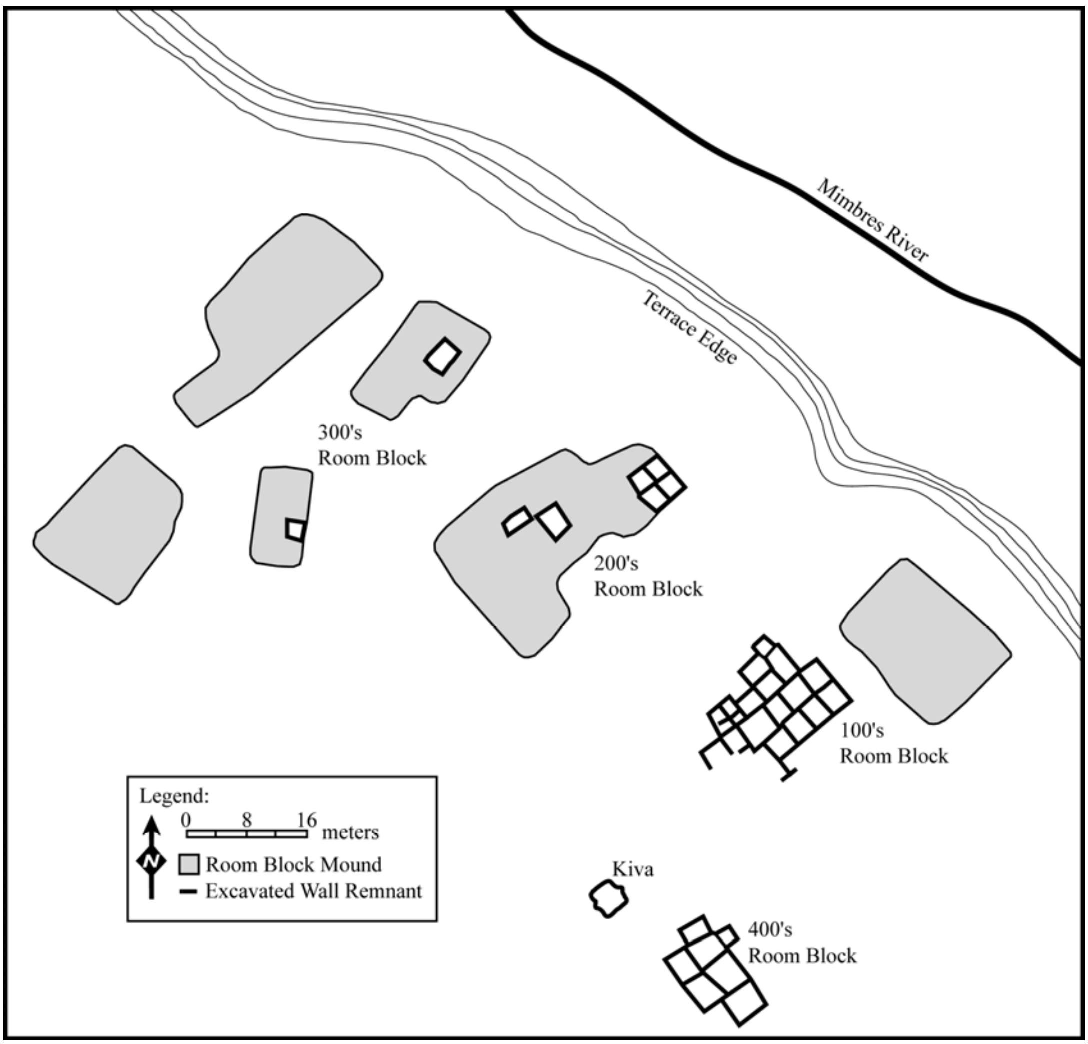


Figure 8: Plan view of the Mattocks Ruin showing the room blocks excavated by the Mimbres Foundation (after LeBlanc 1983).

Galaz Ruin

The history of excavations at the Galaz Ruin (Figure 9) can be traced back to 1927, when a field expedition from the Southwest Museum in Los Angeles visited the site and unearthed about 15 Classic period rooms and four Pithouse period structures (LeBlanc 1983; Anyon and LeBlanc 1984). Then in 1929 an expedition from the University of Minnesota began a research project that would last for three years. During the first field seasons a total of 45 rooms were exposed. Of these, most were Classic period rooms, a few were Pithouse period structures, and two were ceremonial structures. During this first season 362 burials were encountered and 332 whole ceramic vessels were pulled from the room fill (LeBlanc 1983; Anyon and LeBlanc 1984). The following 1930 season unearthed about 23 structures, which yielded 141 whole ceramic vessels, and 113 burials (LeBlanc 1983; Anyon and LeBlanc 1984). In the final field season of 1931, roughly 70 structures, 509 whole ceramic vessels, and 451 burials were excavated (LeBlanc 1983; Anyon and LeBlanc 1984). While the extent of the work conducted by the University of Minnesota is impressive, no formal publications were compiled as a result of this research (LeBlanc 1983; Anyon and LeBlanc 1984). In 1975 the Mimbres Foundation began excavations at the Galaz Ruin (Figure 9) shortly after the

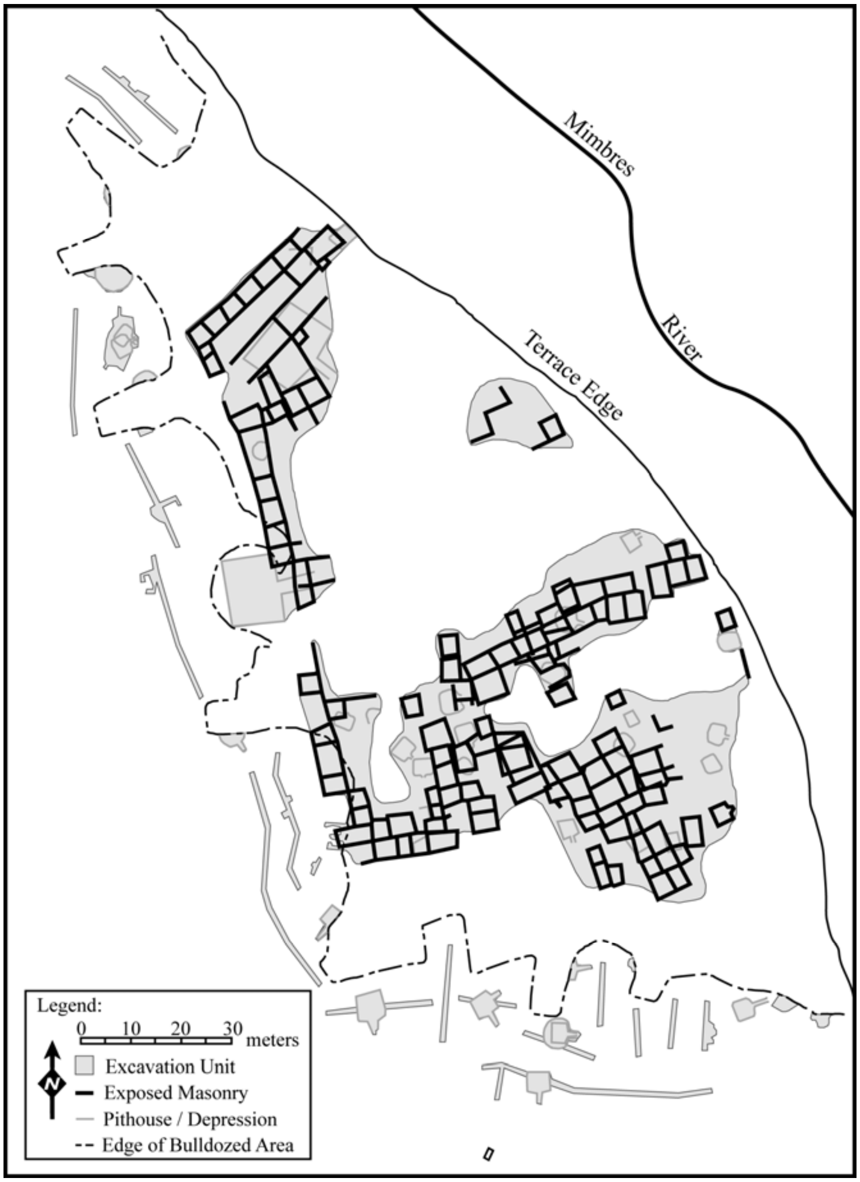


Figure 9: Plan view of the Galaz Ruin showing excavation areas and architectural remains. The majority of the information pertaining to the Classic period room blocks is adapted from the notes of both the Southwestern Museum and the University of Minnesota excavations (after LeBlanc 1983; and Anyon and LeBlanc 1984

conclusion of the first field season at the Mattocks Ruin. This site had been leased to a commercial pot hunter to bulldoze and raze the ruin to the ground in order to extract whole vessels. Rumor has it that the landowner's decision to demolish the ruin came about after an encounter with looters in the middle of the night ended with gunshots being fired at the land owner (Gilman 2004 personal communication). Arrangements were made with the commercial pot hunters to allow the Mimbres Foundation's archaeologists to test and excavate the portions of the site that had not yet been bulldozed. By this time, however, the majority of the Classic period room blocks had been completely razed to the ground and the only portions of the site that were left for the archaeologists to research were Pithouse period components. When excavations began, it became apparent that there could be ways of addressing both the developments occurring during both the Pithouse and Classic periods. This realization was come to by field methodology utilized by the archaeologists and was based primarily on the excavation of pithouse fill in a systematic manner. This fill contained both Classic period and Pithouse period refuse, and by actually screening the fill, a method that was not imposed on the earlier excavations at the Galaz ruin, "valuable information on the ceramics, chipped stone, and faunal and floral remains" were obtained (Leblanc 1983:50). Through their excavations at the Galaz ruin, the Mimbres Foundation was able to reconstruct the developments that occurred at the site during the Pithouse period. The settlement probably began as a small village with about 15 structures and increased in numbers until during the Late Pithouse period, when the settlement consisted of about 45 structures and at least two communal structures (LeBlanc 1983; Anyon and LeBlanc 1984).

Swarts Ruin

Excavations at the Swarts ruin, under the guidance of the Cosgroves, began in the summer of 1924 and continued until 1927 (Cosgrove and Cosgrove 1932) (Figure 10). In the course of their excavations, 172 rooms were uncovered, 47 of which were pithouses, and 125 rooms belonged to the Classic period component at the site. Most of the pithouses found at the site appeared to have burned as was evident by the charred roof timbers and burnt wall plaster encountered while excavating the structures. The Classic period component of the site consisted of two multiroom blocks, the Cosgroves' "North House" and "South House," which were separated by a plaza area (Cosgrove and Cosgrove 1932: 13). A total of 1009 burials were recovered from the site, most of which the Cosgroves attributed to the Classic component except for cases where the individual was clearly associated with Pithouse period structures' floors.

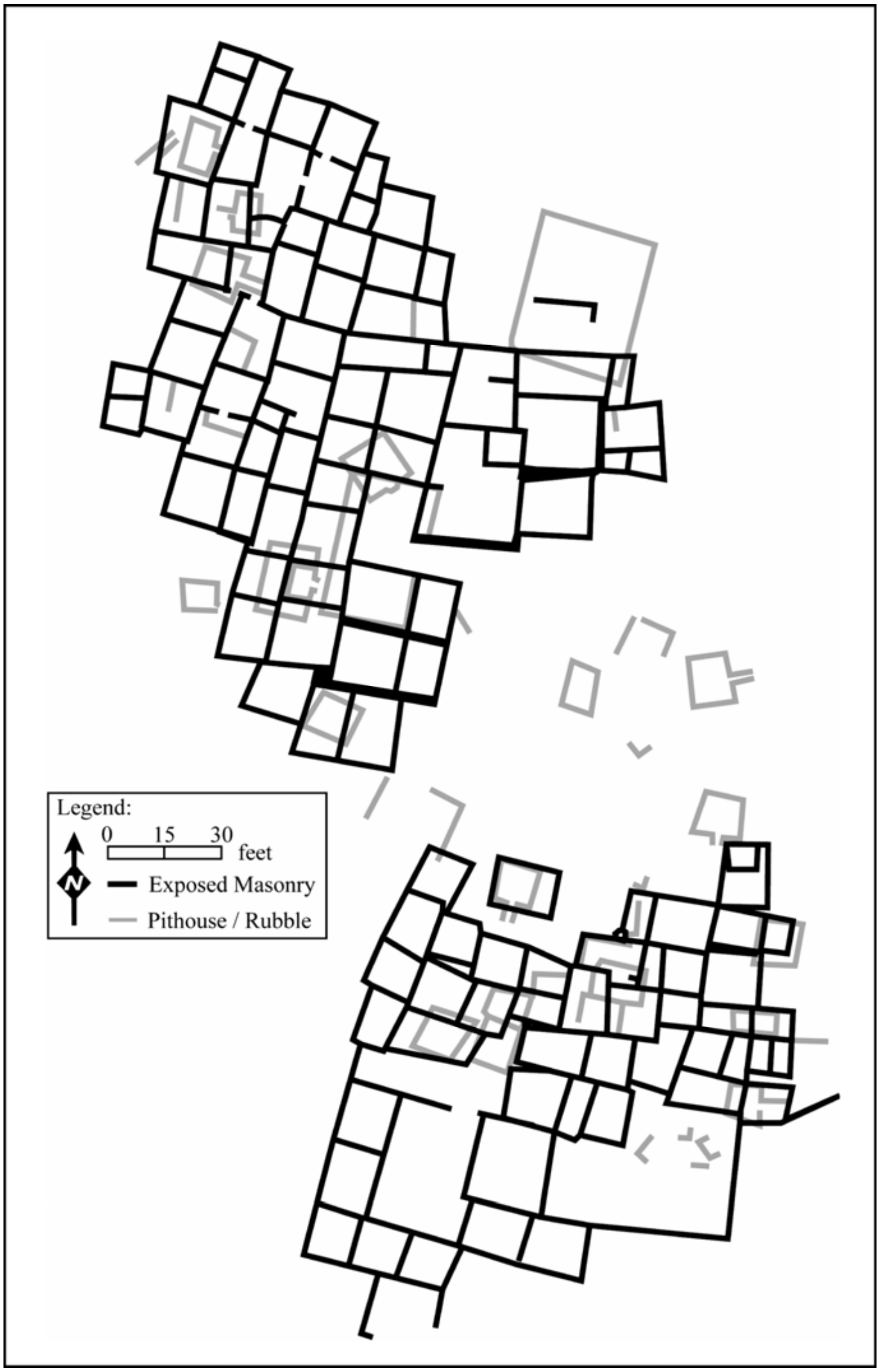


Figure 10: Plan view of Swarts Ruin showing exposed room blocks and pithouses (after Cosgrove and Cosgrove 1932).

NAN Survey Sites

The NAN Ranch Research Project began in 1978 with the excavations of the NAN Ranch ruin by the Texas A&M University field school under the guidance of Harry Shafer. The project conducted excavations at the NAN Ranch ruin for 11 years, and has contributed to our understanding of the ancient Mimbreños. Numerous publications have been completed as a result of this research project (e.g. Shafer 1990, 1991a, 1991b, 1991c, 1991d, 2003; Shafer and Brewington 1995; Shafer and Taylor 1986). As part of the NAN Research Project, surveys were conducted along the Mimbres River and along its side drainages in order to discern the larger settlement pattern within which the NAN Ranch ruin was interdigitated. In 1986 and 1987 the Gavilan Canyon side drainage was surveyed by the NAN Ranch Project in order to locate architectural sites and agricultural features (Figure 11) (Pyne 2004). During this survey, all of the river terraces were examined, "but few of the steeper slopes and none of the active channels" were investigated. During the course of this survey, random samples of diagnostic artifacts were collected from each identified site (Pyne 2004: 25). Table 1 shows the temporal association of each site, these assessments are based on architectural remains and ceramic cross-dating.

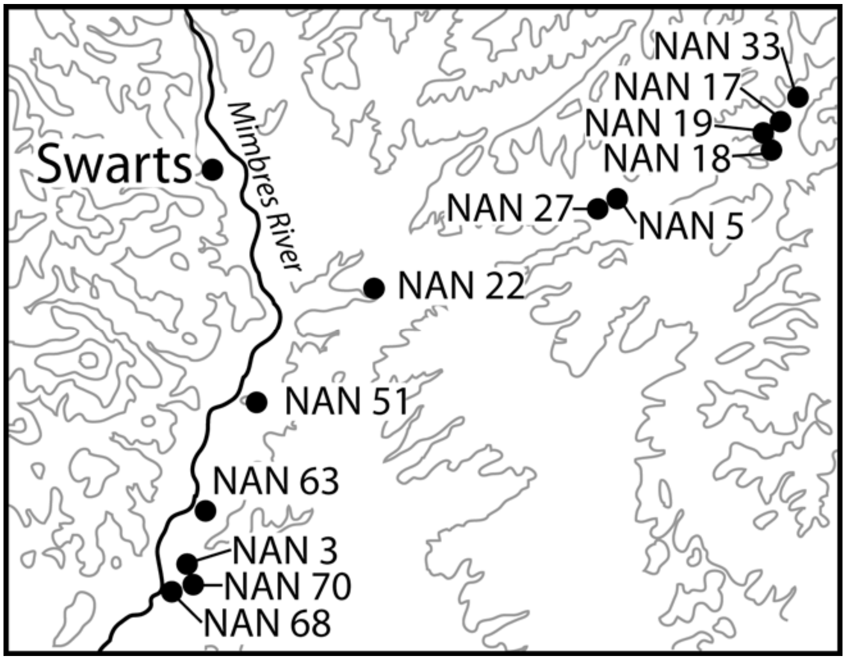


Figure 11: Map depicting selected sites found during the NAN Survey. See Figure 2 to see how this area articulates with the other sites discussed above. The Swarts Ruin was not part of the survey area, which primarily focused on Gavilan Canyon, but is included as a reference point.

NAN Site Number	LA Number	PA	EP	LP	C
NAN 3	73842			X	X
NAN 5	73823	X	X	X	X
NAN 17	73826		X		X
NAN 18	73827			X	
NAN 19	73828			X	
NAN 22	73831		X	X	
NAN 27	73836			X	
NAN 33	73842		X	X	X
NAN 51	73859			X	X
NAN 63	73871			X	
NAN 68					
NAN 70	15059		X	X	

Table 1: Estimated period of occupation for selected sites located during the NAN Survey, where “PA” = Paleo / Archaic period, “EP” = Early Pithouse period, “LP” = Late Pithouse period, and “C” = Classic period (information taken from Creel 1986, 1987 in Pyne 2004; and Pyne 2004).

Chapter V: Technological and Typological Analysis of Formal Chipped Stone Tools from Old Town

Technology is often seen as a combination of various ideas, behaviors, and materials that allows people to accomplish desired ends. These behaviors exist in a complex web and are interconnected with other behavioral linkages within both the cultural and natural world. While the performance of these behaviors is dictated by culture, their performance takes place in a real world, and is therefore conditioned, to a certain extent, by the natural surroundings within which the culture is enmeshed. From an archaeological perspective, the abstract constituents of a technology, ideas and behaviors, can only be inferred through the analysis of the materials producing, and those produced by, technology: artifacts. Most studies focusing on cultural technologies often utilize what some call a *chaîne opératoire* (a.k.a. life history) approach, which investigates the sequence of events that leads from raw material procurement to a finished cultural product, or a behavioral chain approach, which looks at the cultural / behavioral interactions that take place for all of the steps within the *chaîne opératoire* (Dobres and Hoffman 1999, Lamotta and Schiffer 2001, Schlanger 1994, Van der Leeuw 1994).

The analysis of "lithic technology" is essentially the holistic study of stone tools that includes culturally prescribed methods of production, distribution, consumption, life cycle of use, and eventual deposition within the archaeological record. A detailed analysis of the aspects of lithic technology within the Mimbres

Mogollon culture is not presented here since the issue has been sufficiently dealt with by Dockall and others (i.e. Nelson 1984, 1986). These studies focus on a full range of attributes for various lithic artifacts, and both tend to lead to the same conclusion: that the lithic technology of the Mimbres Mogollon was an expedient technology that predominantly made use of locally available raw materials and developed as an adaptive mechanism to both the local environment and to an increased dependence on agricultural goods. My study focuses on the portion of the lithic technology dealing with the production, consumption, and discard of formal flaked stone tools at the Old Town site.

The *chaîne opératoire* utilized in this study is depicted in Figure 12 and its sequence of events is described below. The first step within the process of stone tool production is the procurement of the raw material from which a tool will be fashioned. Two types of procurement are possible: direct procurement and embedded procurement (Binford 1979). Direct procurement refers to individuals going to the source and obtaining the raw material independent of other activities, and embedded procurement refers to the acquisition of raw material in association with other activities such as trade or the procurement of other resources. Once the material has been secured, the next step in the process is the reduction of raw material into the desired form. This is usually accomplished by either grinding the raw material into the desired form, or by removing portions of the lithic material by

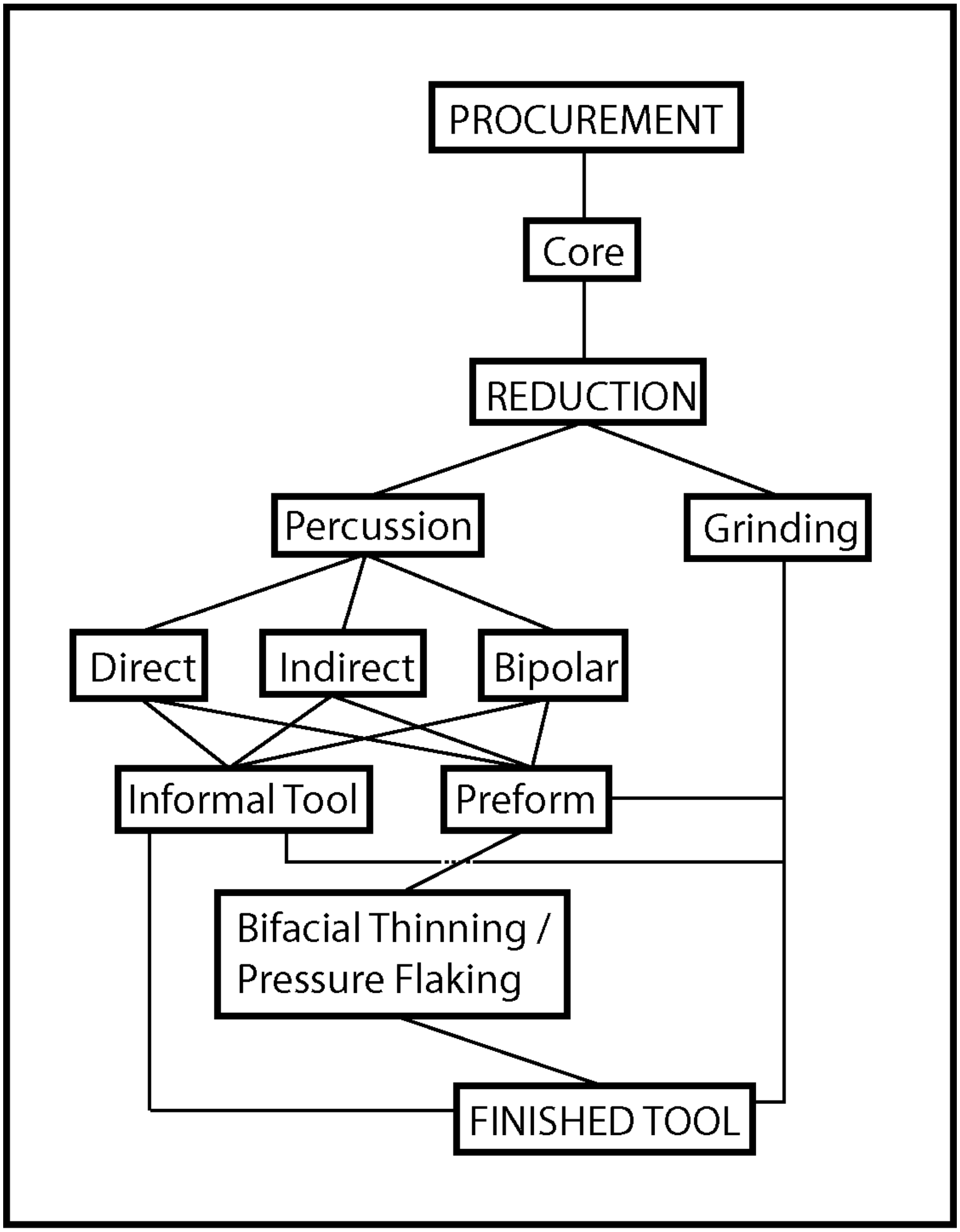


Figure 12: Simplified lithic tool *chaîne opératoire* leading from raw material procurement to finished tool.

percussion. The former is referred to as ground stone technology and the latter is referred to as chipped stone technology. Ground stone technology will not be dealt with in this study, but chipped stone technology will be addressed below.

There are three methods of percussion that allow portions of a core to be removed, these are: direct percussion, indirect percussion, and bipolar percussion. The reduction strategy utilized by the knapper is often conditioned by both the desired end product and the raw material. Thus, direct and indirect percussion are best applied to cores that are relatively large in size, and bipolar percussion is best suited to materials that are relatively small. Direct percussion is when the knapper applies force directly to the core using either a soft or hard hammer. Indirect percussion occurs when flakes are removed by applying force to an intermediary object between the hammer and the core, such as a punch that is used to remove blades from a blade core. Bipolar percussion takes place when the core is placed on a surface and force applied at the opposite end using a hammer.

These three methods of reduction produce diagnostic flake types, and when debitage is recovered from an archaeological site, these attributes can be used to infer the type of reduction utilized in the manufacture of different materials. Direct percussion can produce a wide range of flake type and, depending upon the material being worked and the proficiency of the knapper, can be an efficient way to reduce various material in a wide range of core sizes. Indirect percussion is an efficient way to reduce cores and is usually utilized in the production of blades, although this is not the only manner to produce these artifacts.

Bipolar percussion is most often utilized in the reduction of small cores (i.e. obsidian nodules) and generally produces diagnostic shatter with the objective being the production of a thin sliver. When force is applied to the object, shock waves travel through the material to the opposite end, while at the same time the initial impact from the hammer also causes shockwaves to travel from the anvil in the opposite direction of those initiated from the hammer blow. When successfully conducted, these shockwaves bend and travel in opposite directions, producing a single flake from the core which is then taken to the next stage within the reduction sequence.

Often, the flake is the desired end product and the reduction sequence ends; but where other, more formal, tools are desired, the sequence continues and further reduction of either the core or the flakes takes place until the desired product is reached. Often this necessitates the introduction of another reduction strategy: pressure flaking. Pressure flakes are a product of direct percussion, but instead of applying force directly using a hammer impact to remove flakes, the process of pressure flaking utilizes a method that applies a load force to the surface of the artifact using a pointed instrument (i.e. Ishi Stick, antler tine). The flake is removed by the load pressure exerted on the surface rather than the impact exerted by direct percussion and produces diagnostic flake types in the process. If at this point the tool has been reduced to the desired end, the reduction sequence ceases, and the tool is utilized. Two tool types can be produced in this manner: unifacial tools, tools that have been reduced on only the ventral or dorsal sides; and bifacial tools, tools that have been reduced on both the ventral and dorsal sides.

If further reduction is required to finish the bifacial tool, then the preceding stage in the reduction sequence is termed a preform. Further reduction is carried out removing bifacial thinning flakes through pressure flaking, or in some cases by hammer percussion, until the desired product is reached. The most common forms of bifacial tools are projectile points and knives.

Within each of the stages of the reduction sequence, an artifacts reduction can cease and the tool can be considered a finished stone tool. Usually artifacts that cease to be reduced past the flake and uniface stages are termed informal tool types, and those that continue to be reduced bifacially are termed formal tools. What follows is an analysis that predominantly focuses on the formal chipped stone tool assemblage recovered from Old Town. Core tools are not included in this analysis although they are the most common chipped and/or battered stone tool at the site.

Typology

As stated earlier, the late prehistoric Southwest has been characterized by a comparative paucity of thorough analyses concerning lithic technology. In part this is a result of the lack of a formal typology for differing cultural areas. This, however, is changing and Southwestern archaeologists are paying increasing attention to lithic assemblages. The objectives of this portion of the study are to contribute to the growing database of information concerning the nature of Mimbres Mogollon lithic technology and to place the projectile points recovered from excavations at the Old Town into morphological types.

The assignment of each point to a type was based on the morphological characteristics and, to the extent possible, used the categories outlined in Dockall's (1991) analysis of chipped stone artifacts from the NAN Ranch ruin. Some specimens, however, could represent separate types or reworked / refurbished specimens not readily assignable to one of Dockall's types. The attributes used to place a projectile point into a type were: size, notch type, stem morphology, and the amount of retouch present on the point's lateral and ventral / dorsal surfaces. The general type descriptions are outlined below with a brief metric analysis of the arrow and dart points presented in Table 2 and Table 3. The metric analysis is based on the number of specimens, both complete and fragmentary, from which measurements of maximum length, width, and thickness could be discerned. A more complete list of metric attributes can be found in the appendices.

Arrow Points:

There was a total of 128 arrow points that were recovered from Old Town. A large portion of these were assigned to nine types (Cosgrove, Hinton, Mimbres, Swarts, A1, A2, A3, A4, and A5) in the typology created by Dockall (1991) for specimens recovered from the NAN Ranch ruin.

Cosgrove: N=27 (Figure 13)

These points are small triangular side-notched projectile points with multiple side notches on one or both of the lateral edges. The blade edges are straight and lateral haft element edges range from straight and expanding to straight and contracting, to convex to concave. Basal edges vary from straight to slightly convex to slightly concave. Most specimens exhibit two side notches on one lateral blade edge, but a possible variant of this type has multiple notches extending the entire length of the blade edges, producing a deeply serrated triangular point. A total of 27 points were assigned to this type, 22 of which were fashioned from obsidian, four from chalcedony, and one was chipped from chert. This group comprised 21% of the arrow point assemblage. Dockall (1991) states that these points were predominantly found in Classic period contexts at the NAN Ranch ruin but that some are found in transitional phase contexts (Dockall 1991: 223).

Hinton: N= 21 (Figure 13)

Hinton points are small, triangular side-notched points with straight to convex lateral blade edges and a concave basal edge. The basal cavity ranges from a smooth concave edge to an abrupt notched angular edge. Lateral haft element edges vary from straight and expanding to convex / rounded. Again, a possible variation in form may be present as some specimens classified under this type have smaller blades that could be the work of intentional craftsmanship or

Figure 13: Arrow point types within the Old Town assemblage. Types depicted are A1, A2, A4, Swarts, Mimbres, Hinton, and Cosgrove. Notation under each point represents the point type and the specimen number for each type. “S3” represents Swarts point type specimen number 3; “M1” represents Mimbres point type specimen number 1; “H1” represents Hinton point type specimen number 1; and “C5” represents Cosgrove point type specimen number 5.

Point Type	Number of Specimens	Mean Max. Length	Max. Length Range	Mean Max. Width	Max. Width Range	Mean Max. Thickness	Max. Thickness Range
Cosgrove	27	19.83mm	14.8mm - 26.0mm	9.64mm	8.6mm - 11.2mm	3.14mm	2.8mm - 3.9mm
Hinton	21	22.73mm	16.5mm - 30.8mm	11.61mm	8.8mm - 14.4mm	3.14mm	1.8mm - 4.2mm
Mimbres	21	21.22mm	11.1mm - 52.1mm	11.34mm	8.6mm - 14.3mm	2.98mm	1.8mm - 3.9mm
Swarts	25	18.77mm	12.3mm - 28.1mm	9.89mm	7.2mm - 12.9mm	2.99mm	1.9mm - 4.5mm
A1	7	18.23mm	14.0mm - 23.1mm	12.6mm	9.9mm - 15.1mm	3.04mm	2.2mm - 4.6mm
A2	10	15.83mm	14.9mm - 16.8mm	8.75mm	7.9mm - 9.7mm	3.1mm	2.4mm - 4.2mm
A3	9	19.78mm	12.0mm - 24.8mm	10.37mm	8.9mm - 12.0mm	3.12mm	1.7mm - 4.8mm
A4	7	23.33mm	22.7mm - 23.8mm	9.43mm	8.9mm - 10.1mm	4.53mm	3.4mm - 5.9mm
A5	1	23.9mm		11.1mm		3.2mm	

Table 2: Descriptive statistics for arrow points recovered from Old Town

could be the result of the reworking of longer Hinton point blades. Some of these specimens are reworked to the extent that the side notches are only faintly recognizable and the lateral blade edges are concave. Hinton points made up 16% of the arrow point assemblage recovered from Old Town. Of these, ten were made from obsidian, six were formed from chert, and five were chipped from chalcedony. Dockall (1991) states that Hinton points were primarily found in Classic contexts at the NAN Ranch ruin.

Mimbres: N=21 (Figure 13)

These points are small, triangular, and have corner-notched bases. Lateral blade edges vary from straight to slightly convex. The basal edges vary from straight to convex with convex being the most prevalent. There is perhaps another type present within this type classification as there are two specimens with straight bases and straight lateral blade edges well above the mean blade edge length. The 21 Mimbres points comprise 16% of the total arrow point assemblage at Old Town. Fourteen were made from obsidian, three of rhyolite, and two each of chert and chalcedony. Dockall suggests that Mimbres points "are not associated with the Classis period" at the NAN Ranch ruin, "and that those found in Classic contexts are the result of the prehistoric disturbance of earlier occupational phases" (Dockall 1991: 225).

Swarts: N=25 (Figure 13)

Swarts points are small, triangular side-notched arrow points that exhibit a broad range of basal edge morphology. Lateral blade edges are usually straight, but convex and concave lateral blade edges are not uncommon. Haft element edges range from convex to straight and expanding or parallel. A total of 25 points, representing roughly 20% of the arrow point assemblage, were placed within this type. Of these, 20 were made of obsidian and five were chipped out of chert. Dockall states that Swarts points are thought to be a Classic period form at the NAN Ranch ruin (Dockall 1991: 228).

Type A1: N=7 (Figure 13)

Type A1 points are small triangular to oval arrow points with no notching or stem present. Lateral blade edges range from straight to convex, as do the basal edges. Seven Type A1 points, comprising 5% of the arrow point collection, were recovered from the excavations at Old Town, all but one were formed from chert. The exception was fashioned from obsidian. This type could represent points in a preform stage, as Dockall (1991:228-229) notes. Dockall suggests that these points were primarily found in Classic period contexts at NAN, but some occurred in Transitional and Three Circle phase contexts.

Type A2: N=10 (Figure 13)

Type A2 points are small, triangular corner-notched arrow points with parallel to expanding stems. The lateral blade edges are usually straight but some specimens exhibited both concave and convex blade edges. Shoulders are generally horizontal but a few specimens were barbed and could possibly be defined as another type. These barbed specimens also possess serrated lateral blade edges and are usually larger than their straight edged horizontally shouldered counterparts. Of the ten points (8% of the arrow point assemblage) placed within this type, six were chipped out of obsidian, two were made of chert, and one each of chalcedony and rhyolite were utilized as raw materials. Dockall (1991:229) states that most Type A2 points were found within Classic period contexts at NAN.

Type A3: N=9

Type A3 points are small triangular arrow points fashioned from flakes with little retouch so that the original flake attributes are still discernable. Nine specimens, or 7% of the arrow point assemblage, were placed in this grouping. Of these, six were chipped from obsidian, two from chert, and one from chalcedony. Dockall (1991:230) notes that at NAN these points are associated with Classic Period and Three Circle phase contexts.

Type A4: N=7 (Figure 13)

These arrow points were generally side-notched triangular points with straight to convex slightly serrated lateral blade edges. All specimens have expanding stems and straight to convex basal edges. A total of seven specimens, 5% of the arrow point collection, were placed into this type, all of which were fashioned from obsidian. Dockall (1991: 230-231) states that this group was created within his typology to accommodate those points that were not easily assigned to another group, and that some of these may represent reworked examples of other point types.

Type A5: N=1

Type A5 points are fashioned from flakes and retain flake scar attributes, but unlike Type A3, there is unifacial pressure flaking completely covering either the ventral or dorsal side. This retouch flaking is carried out on all edges. The lone representative of this type from Old Town is a triangular side notched arrow point with straight lateral blade edges, straight to convex lateral haft element edges, and a straight to slightly convex basal edge. Dockall (1991:2321-232) notes that these points are found in Classic period, Three Circle phase, and San Francisco phase deposits at the NAN Ranch ruin.

Dart Point Descriptions:

A total of 22 dart points (Figure 14) were recovered from Old Town and were discriminated from arrow points by their larger overall size. These were assigned to six of the categories (Chiricahua, San Pedro, D1, D2, D4, and D5) in the topology created by Dockall (1991) for specimens recovered from the NAN Ranch ruin. Point types PA1 and PA2 possibly represent Paleo Indian or Early Archaic point forms.

Figure 14: Dart point types within the Old Town assemblage. Types depicted are San Pedro, D1, S2, D4, D5, PA1, and PA2. Notation under each point represents the point type and the specimen number for each type. "SP3" represents San Pedro point type specimen number 3

Point Type	Number of Specimens	Mean Max. Length	Max. Length Range	Mean Max. Width	Max. Width Range	Mean Max. Thickness	Max. Thickness Range
Chiricahua	2	40.2mm		25.1mm		5.4mm	
San Pedro	6	55.23mm	37.8mm - 80.7mm	20.37mm	18.7mm - 23.3mm	6.7mm	5.8mm - 8.2mm
D1	8	34.97mm	30.7mm - 43.2mm	19.63mm	18.5mm - 20.4mm	4.23mm	4.0mm - 4.6mm
D2	1	40.7mm		24.1mm		6.4mm	
D4	1	30.9mm		20.0mm		6.3mm	
D5	4	35.88mm	24.2mm - 42.8mm	21.55mm	16.5mm - 26.5mm	4.65mm	3.8mm - 5.4mm

Table 3: Descriptive Statistics for dart points recovered from Old Town

Chiricahua N=2

The main diagnostic feature of this dart point type is the presence of an eared stem. Lateral edges vary from straight to convex and the basal edge is concave due to the presence of a basal notch. Both specimens have barbed shoulders. Two of these points, comprising 9% of the dart point assemblage, were excavated at Old Town. One was fashioned from chert, and the other was made out of rhyolite. Dockall (1991: 232) observes that the specimens recovered from the NAN Ranch Ruin were heavily reworked and believes that they were Archaic points collected off-site for secondary use. He states that these points were found in Classic period and Three Circle phase contexts but that the Chiricahua point "is associated with the Chiricahua Stage dated geologically between 3500 to 8000 B.P." (Dockall 1991:232).

San Pedro: N=6 (Figure 14)

In this type are large to medium-sized slender dart points with straight to convex lateral blade edges. The expanding stems were manufactured by percussion flaking that produced deep, broad notches. Shoulder orientations vary from horizontal to tapered and basal edges vary from straight to convex. Six San Pedro points, or 27% of the dart point assemblage, were found and placed into this type. Three were formed from chert, two from chalcedony, and one was made out of rhyolite. Dockall (1991: 234) suggests that there are two varieties of this type, a large and a small, with the large variety preceding the smaller variety. This division is not utilized here as the smaller variant was probably just reworked and thus shortened. It is possible, though, that stem variation in this type may have as yet unrecognized temporal significance.

Type D1: N=8 (Figure 14)

Corner notches, straight to convex lateral blade edges, and an expanding stem, characterize this medium sized dart point. Basal edges range from straight to convex. Eight type D1 points were found at Old Town and represent 36% of the dart point assemblage. Of these, six were formed from chert and two were chipped from chalcedony. Dockall (1991: 237) attributes this point to Classic period and late Three Circle phase deposits at NAN.

Type D2: N=1 (Figure 14)

Type D2 points are medium sized triangular points with side notches, straight to convex lateral blade edges and a convex basal edge. One type D2 point was recovered at Old Town. This specimen was chipped from schist and comprises roughly 5% of the dart point collection. Dockall (1991: 238) states that this point type was found in Classic period, Three Circle phase, and San Francisco phase deposits at the NAN Ranch Ruin.

Type D4: N=1 (Figure 14)

Type D4 specimens are medium sized triangular points with corner-notched stems that range from expanding to parallel. Shoulders are barbed and basal edges range from straight to convex. One chalcedony point from Old Town was typed as a D4 form. Dockall (1991: 239) states that this point was found within Classic period and Three Circle phase contexts at NAN.

Type D5: N=1 (Figure 14)

These points are medium sized corner-notched triangular points. Lateral blade edges vary from straight to concave or convex and basal edges vary from straight to convex. Shoulder orientation varies from horizontal to barbed. Four Type D5 points were recovered from Old Town and these represent 18% of the dart point collection. Two are made out of chert, one of obsidian, and the other out of chalcedony. Dockall (1991: 240) states that points grouped into this type were recovered form Classic period, San Francisco phase and Three Circle phase components at the NAN Ranch Ruin. Dockall also notes that this point was the most common dart point found at the NAN Ranch Ruin and cites various other studies in the Mogollon area that report similar findings.

Untyped Whole Specimens (Figure 14: PA 1, PA 2):

There were two whole specimens what were recovered from excavations at Old Town that were not assignable to any of the groupings outlined by Dockall. Both appear to be early point types predating any known occupation at Old Town and are interpreted by Creel (2004) as possibly having been deliberately placed in construction material as dedicatory objects. Specimen PA-1 has a maximum length of 37.1mm, a maximum width of 17.8mm, and a maximum thickness of 3.4mm. This specimen was recovered from wall-fall associated with Room A83 a Three

Circle phase kiva. Specimen PA-2 has a maximum length of 27.3mm, a maximum width of 16.9mm and a maximum thickness of 2.9mm. This dart point was found in wall-fall associated with Room A59, probably also a Three Circle phase pitstructure.

Miscellaneous Tools:

Tabular Tools (Stone Hoes)

Seven artifacts recovered from Old Town were placed within the category of chipped stone tools generally referred to in the Mimbres area as hoes (Figure 15, and Table 4), and, next to the projectile points, were the most abundant formal chipped stone tool. All appear to have come into contact with a high heat source due to the fact that the majority of the artifacts have carbon residue present on one or both of the ventral or dorsal sides, but this discoloration could be the result of patination. They are made out of a rhyolite and have been worked along the margins. The negative flake scars terminate in either a step or hinge fracture, and this is probably due to the coarseness of the material. These step and hinge terminations could coincide with the evidence of battering along the lateral margins where there are also traces of polish or residue accumulation. They resemble large bifaces (2 in excess of 20cm) but are not completely bifacially worked; rather they are bimarginal flake tools with both margins being worked along both the ventral and dorsal faces. They are relatively thin (5-10mm thick); and on both the ventral

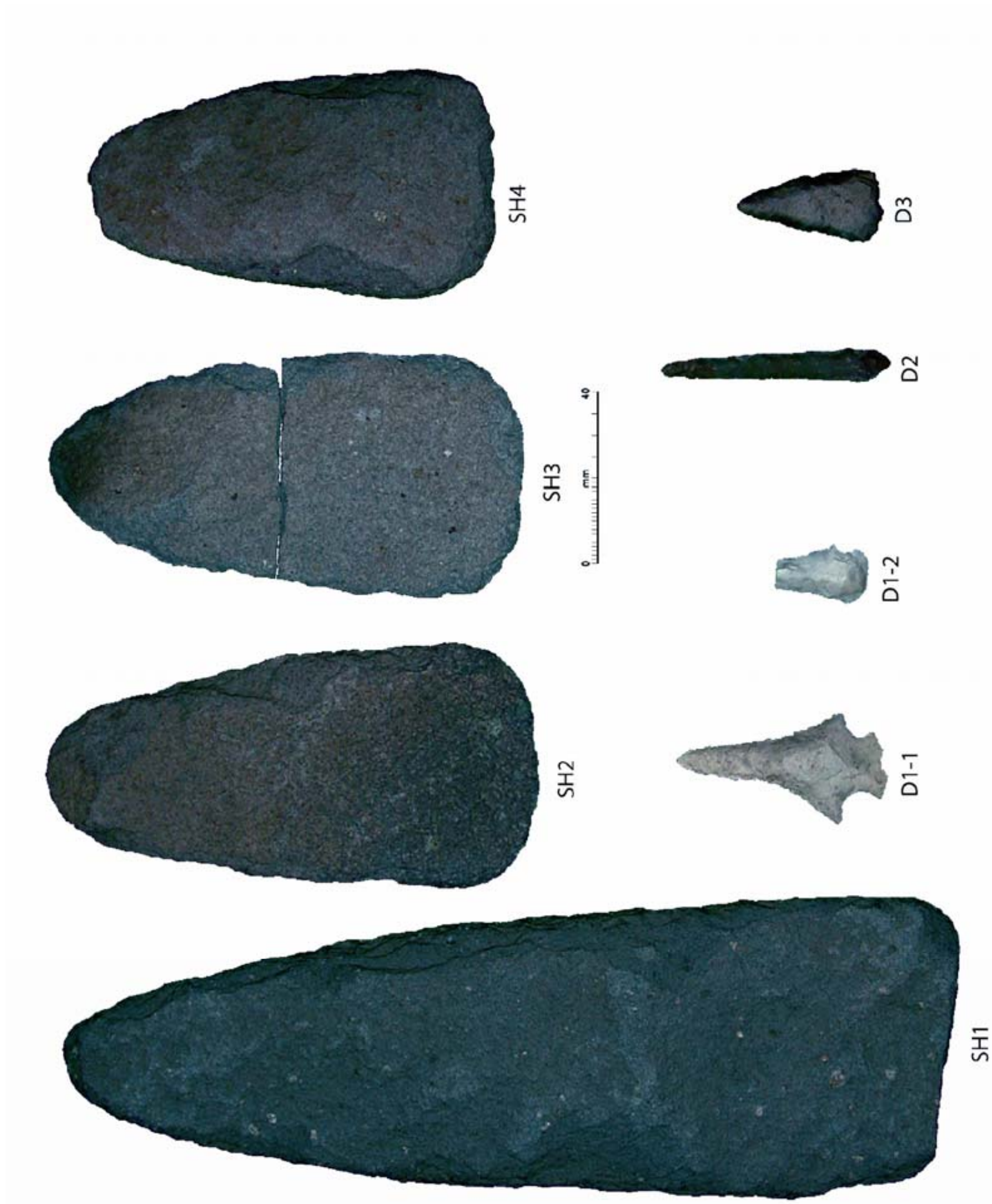


Figure 15: Sample of tabulas tools and drills specimens revocered from Old Town

	Maximum				
Specimen #	Length	Width	Thickness	Provenience	Notes
1	204.2mm	70.1mm	13.9mm	Area:B Unit:4 Rm:B2 Lot: 824	Polish on high profile areas on both the ventral and dorsal surfaces, battering on lateral margins and perhaps polish there as well, step and hinge fractures persent along margins
2	114.2mm	56.9mm	7.2mm	Area:B Unit:4 Rm:B2 Lot:1075	Polish on high profile areas of one surface, discoloration on proximal bit, step and hinge fractures along lateral margins
3	108.8mm	56.0mm	9.1mm	Area:B Unit:21 Rm:B11 Feat:B11-18 Lot:2580	Fragmented in 2 pieces, no polish but carbon residue present on distal bit
4	94.2mm	53.4mm	10.7mm	Area:B Unit:5 N1055/E955 Lot:1146	Polish on high profile areas on both surfaces, step/hinge fragturing along lateral margins, perhaps polish along lateral margins as well
5	Fragment	Fragment	Fragment	Area:B Unit:21 Rm:B11 Lot:2145	Distal fragment, carbon discoloration / patination on both faces and extending halfway through cross-section, longitudinal and transverse striations present on both faces with step/hinge fractures cutting into striations, polish on both faces (no magnification)
6	Fragment	Fragment	Fragment	Area:B Unit:21 Rm:B11 Lot:2272	Medial fragment, discoloration (carbon/patination) on both faces, polish present on both faces and along lateral margins, step/hinge fractures along lateral margins, mostly longitudinal striation (no magnification)
7	Fragment	Fragment	Fragment	Area:B Unit:21 Rm:B11 Lot:2381	Distal fragment, carbon discoloration / patination on both faces and extending halfway through cross-section, polish present on one face, step/hinge fractures present along lateral margins, perhaps pot-lid fracture present on one surface

Table 4: Descriptive attributes on tabular stone hoe blades recovered from Old Town

and dorsal sides, there are areas of highly polished wear, perhaps from contact with a mild abrasive.

Tabular tools are referred to by Jenny Adams (2002) as “thin tabular pieces of stone of varying sizes, with one or more edges used in cutting, scraping, slicing, or chopping motions” (Adams 2002:189). Thus, they are used to describe a whole suite of artifact forms that are fashioned from material that fractures naturally with a desired form or requires little marginal retouch to manufacture the desired form. One possible form of tabular tool found at the Old Town site is that of tabular stone hoe blades. Adams states that these tabular hoe blades are sometimes shaped by flaking, and that they are primarily found in Classic period contexts from sites in central Arizona (Adams 2002: 177).

Anyon and LeBlanc (1984: 280) note that during the Mimbres Foundation’s excavations of sites throughout the Mimbres Valley, only eight artifacts resembling tabular stone hoe blades were recovered and that most of these were recovered from excavations at the Mattocks site. From their analysis of the distribution of these artifacts recovered from previous excavations, especially at Mattocks and Galaz, it is evident that these artifacts are usually found in caches from Classic period contexts (Anyon and LeBlanc 1984: 280). However, at Old Town, all of the “hoes” were found in Three Circle phase contexts in Area B, with some being incorporated into pithouse architectural material. Four were found in kiva Room B11, two in the south wall of pithouse B2, and one possible in the wall of Room B6.

As other scholars have noted, the wear pattern present on these artifacts does not match the wear pattern characteristic of agricultural implements (Cosgrove and Cosgrove 1932; Anyon and LeBlanc 1984). None of these stone hoes' distal tips exhibits evidence of wear like other agricultural implements (i.e. digging sticks) where distal element of the tool repeatedly came into contact with abrasive soils. Their predominant occurrence in unusual contexts and not, to my knowledge, in field areas, suggests that they had other, non-agricultural uses. It is worth noting that those specimens recovered from Room B11 were all fragmented and could represent dedicatory objects similar to those found in Room A16 (Creel and Anyon 2003).

Drills

Four artifacts recovered from the excavations at Old Town are classified as drills. Two of these specimens (Figure 15: D1-1 and D1-2) probably represent the reworking of projectile points in that they retain many characteristics used to group projectile points into Dockall's typology. These characteristics are primarily side notches and their relatively larger size. They are classified as drills here by the presence of concave lateral blade edges that are indicative of continuous refurbishing and by the presence of smoothing at the tools' distal ends. Another specimen is classified here as a drill due to its relative thinness, lack of characteristics associated with projectile points, and evidence of wear at the distal end of the tool (Figure 15: D2). The last drill specimen is similar in form to Type

A1 arrow points in that it is triangular in shape (Figure 15: D3), but unlike this projectile point type, the drill lacks evidence of bifacial thinning and has evidence of wear as the distal end.

Biface Fragments and Informal Tools

Within the Old Town site assemblage there were 13 biface fragments that could not be assigned to a type due to their size and lack of distinguishing characteristics. Most of these fragments were the distal ends of arrow points. There were 33 biface fragments that went unidentified for the same reasons, most of these were also distal fragments.

Lastly, there were 24 flakes and flake fragments in the assemblage that probably represent informal tools, but no use wear analysis was conducted on the specimens. It is virtually certain that the number of informal tools present in the assemblage is far greater than this 24; but in the absence of a formal use-wear analysis of the debitage, this is still assumed. Artifacts were classified as informal tools based on either the presence of retouch along the flake's margins, or on the presence of negative micro-flake scars along the margins. The later could have resulted from the artifact's use, but many other natural agents could have caused the artifacts to exhibit these features. Of these 24 informal tools, one was a primary chert flake, one was a primary anedsite flake, three were secondary flakes of either chert or chalcedony, six were tertiary flakes chipped from chert and chalcedony, four were secondary andesite flakes, seven were secondary rhyolite flakes, and one was a tertiary rhyolite. This last specimen, the tertiary rhyolite flake fragment, is unique in that it possesses a highly polished margin indicative of prolonged use. This flake fragment is also larger than most of the flakes present in the assemblage. Its maximum length is 160.3mm and its maximum width is 130.5mm. The polished along the margin is reminiscent of sickle sheen and extends up the ventral side 6mm.

Spatial Analysis

In her analysis of flaked lithic artifacts from the Janss, Stailey, and Disert sites of southwestern New Mexico, Nelson (1986) came to the conclusion that defining types by utilizing a "multivariate technique to identify interaction among nominal variables of point form…does not show temporal patterning," and that there are no "points distinctive to any phase of occupation in the Mimbres Valley" (Nelson 1986: 156). One possible reason for this conclusion is that point types have a longer use life than their ceramic design styles' counterpart which have been used to construct the region's time-space systematics. Other possible reasons for this inference are (1) the prehistoric disturbance and recycling of fill resulted in considerable mixing of once-stratified deposits, and (2) the prehistoric collecting of older points (e.g. the Clovis point at NAN Ranch [Shafer 2003: 5]). The extensive remodeling of structures within pit house period (see Diehl and LeBlanc 2001) and the later construction of pueblo, necessitated the large-scale movement/transportation of artifact-bearing fill; and, over time, this fill held mixed artifacts from earlier times, their original context was lost.

The best way to identify possible patterning in circumstances where mixed deposits are encountered, is to look for other artifacts/features that exhibit a more comprehensible temporal association and use this artifact/feature's temporal designation to date the lost context artifact by association with a general pattern. Such was possible at the Old Town site, where there was spatial separation of remains of different age (see Figures 2, 3, 4, 5, and 6 for more information concerning site location and the location of excavation areas within the site).

Area A had an assemblage that consisted of 125 projectile points, 83% of the total collection of projectile points (see Table 5). The area yielded at least one example of every point type except for Type D2, 87.2% being arrow points, and 12.8% dart points. Based on this assemblage and given the occupational history of Area A, it is plausible to deduce that all of the defined projectile point types were present in this portion of the Mimbres Valley prior to the end of the Classic period and that those points found in Black Mountain and Cliff / Salado phase contexts were of types first manufactured in earlier periods.

The assemblage collected from Area B had eight specimens and composed 5% of the total projectile point collection excavated from the Old Town site (Table 5). This information suggests that Mimbres points were probably being manufactured during the Late Pithouse period, with San Pedro and D5 points being

	Late Pithouse Period San Francisco Phase					Late Pithouse Period Three Circle Phase					Classic Period				B. Mtn. Phase
	D5	**CH**	**D4**	**D2**	**A5**	**D1**	**San Pedro**	**A1**	**A3**	**Mimbres**	**Cosgrove**	**Swarts**	**A2**	**A4**	**Hinton**
Area A (N=125)	3	2	1		1	6	4	5	8	16	26	25	10	6	12
Area A (N=125 83.33%)	2.40%	1.60%	0.80%		0.80%	4.80%	3.20%	4.00%	6.40%	12.80%	20.80%	20.00%	8.00%	4.80%	9.60%
Area B (N= 8)	1						2			4	1				
Area B (N= 8 5.33%)	12.50%						25.00%			50.00%	12.50%				
Area C (N=16)						2		2	1	1				1	9
Area C (N=16 10.67%)						12.50%		12.50%	6.25%	6.25%				6.25%	56.25%
Area D (N=1)				1											
Area D (N=1 0.67%)				100.00%											
Total Assemblage = 150	4	2	1	1	1	8	6	7	9	21	27	25	10	7	21
100%	2.67%	1.33%	0.67%	0.67%	0.67%	5.33%	4.00%	4.67%	6.00%	14.00%	18.00%	16.67%	6.67%	4.67%	14.00%
Arrow Point Total (N=128)					0.78%			5.47%	7.03%	16.41%	21.09%	19.53%	7.81%	5.47%	16.41%
Dart Point Total (N=22)	18.18%	9.09%	4.54%	4.54%		36.36%	27.27%								

Table 5: Percentages, numbers and distrubution of projectile point types at Old Town.

reused. Although the Area B sample is small, the lack of Hinton points, Swarts points, Type A1 points, Type A2 points, Type A3 points Type A4 points and Type A5 points in Area B suggests that these forms were introduced into the region after about A.D. 950 and that they should be considered largely Classic period types. The single Cosgrove point, found on the surface, may be associated with te sparse occurrence of Classic sherds in Area B and not related to the Three Circle phase pitstructures.

The collection recovered from Area C numbered 16 specimens and comprised 11% of the total projectile point assemblage (Table 5). All but two specimens recovered form this area are arrow points.

This information along with the information from other areas suggests that Cosgrove points were being manufactured during the Late Pithouse period and their production continued up into the Classic period. Hinton points, Swarts points, Type A1 points, Type A2 points, Type A3 points, Type A4 points, and Type A5 points probably all represent point types first produced during the Classic period.

The dart points are more difficult to assign a relative date to because most of the specimens were found within contexts that probably represent the aboriginal use/curation of older artifacts. Two of these specimens were found within the fill from collapsed walls and it is believed that they may have been intentionally placed into the fabric of the architecture. Whether this is the case or whether these points are found their way into these contexts by accident is unknown, but either way, based on Old Town information and regional occurrances, I feel it safe to infer that all dart point types were probably produced in earlier periods but may have been used during the Late Pithouse and Classic periods.

The typological analysis presented in this Thesis is a preliminary study of the formal chipped stone tool assemblage collected during the excavations at Old Town. Further analysis could clarify the temporal range of the types, but as of yet the depositional contexts from which these points are recovered and the reuse of earlier point forms seem not to allow for this type of refinement. I feel that there are point forms that are distinctive of specific phases and that the people who incorporated these types into their subsistence strategy found them useful for more than one archaeologically determined cultural phase.

Chapter VI: Intrasite Analyses of Projectile Point Types and Raw Materials

The focus of this chapter is the analysis of projectile point type, raw material, and context. As discussed previously, the allocation of the different types into temporal intervals was possible because of the spatially and temporally separated nature of the occupational phases at the site. The site can be separated into three areas: Area A, B, and C. Each of these areas has a different occupation history: Area A saw occupation from perhaps the Early Pithouse Period (A.D. 200-550) up through the Classic Period (A.D. 1000-1150); Area B was occupied during the Late Pithouse period (A.D. 550-1000); and Area C was occupied during the Early and Late Pithouse periods, appears to have been abandoned during the Classic period, was reoccupied during the Black Mountain phase (A.D. 1150-1300) (Creel 2005). Tables 5 and 6 shows the temporal range for manufacture and / or later use of each projectile point type.

	Early Pithouse	Late Pithouse	Classic	Black Mountain
	200-550	550-1000	1000-1150	1150-1300
Mimbres		X………	……X…….	……….X
Swarts			X	
Hinton		X*………	…….X……..	……….X
Cosgrove		X*………	………X	
A1		X*………	…….X……..	……….X
A2			X	
A3		X*………	…….X……..	……….X
A4			X	
A5			X	
San Pedro	(?)	X………	………X	
Chiricaua	(?)		X	
D1	(?)		X	
D4	(?)		X	
D5	(?)	X………	………X	

Table 6: Temporal association for projectile point types. "*" = Designation assigned by Dockall for specimens recovered from NAN Ranch but were not found in those contexts at Old Town.

Raw Material and Types

The majority of the projectile point assemblage was manufactured from four lithic materials: chalcedony, chert, obsidian, and rhyolite. The relative proportions of each lithic material show that the most projectile points were manufactured out of obsidian followed by chert, chalcedony, and then rhyolite. Figure 16 shows the numbers and relative proportions of these lithic materials. At the Old Town site 88 points were fashioned from obsidian, 36 from chert, 18 from chalcedony, and 7 were fashioned from rhyolite.

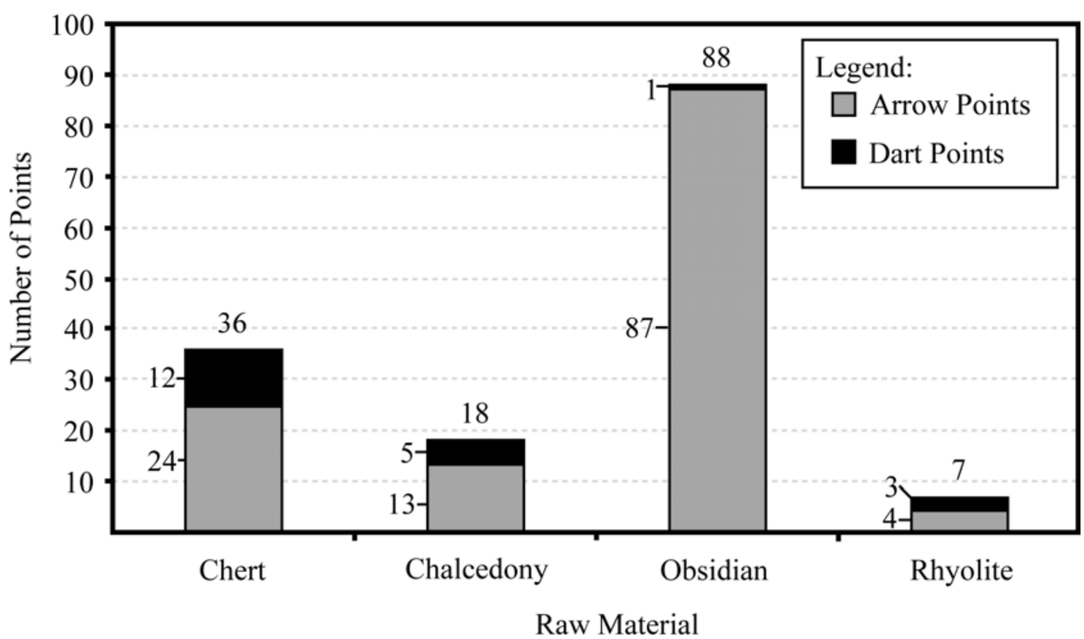


Figure 16: Number of arrow and dart points by raw material

From this information it is possible to discern that obsidian was being chosen over the other lithic materials for the production of projectile points. Because the four excavation areas of the site have different occupational histories it is possible to assign a temporal span to artifacts recovered from the site, and, thus, the distribution of projectile point raw materials was analyzed for temporal significance. Figure 17 shows the number of projectile points fashioned from different materials that were excavated from the different areas at Old Town. Area A contained 81 obsidian points, 27 chert points, 10 chalcedony points, and five rhyolite points. Of the 81 obsidian points, one was a Type D5 dart point and the remaining 80 were arrow point types; of the 27 fashioned from chert, 11 were dart point types and 16 were arrow point types; of the ten chalcedony points, three were dart point types and seven were arrow point types; and of the five rhyolite points recovered from the area, one was a Chiricahua point and the others were arrow point types. A total of eight points were recovered from Area B, of these two were fashioned from all of the lithic materials; obsidian, chalcedony, chert, and rhyolite. Of the two chert points, one was a San Pedro point and both rhyolite points were dart point types. The remaining points recovered in Area B were arrow points. A total of 16 points were recovered from Area C, of which five were made of obsidian, six of chalcedony, and five of chert. Of the six chalcedony points, two were Type D1 points. The other 14 points recovered from Area C were arrow point types.

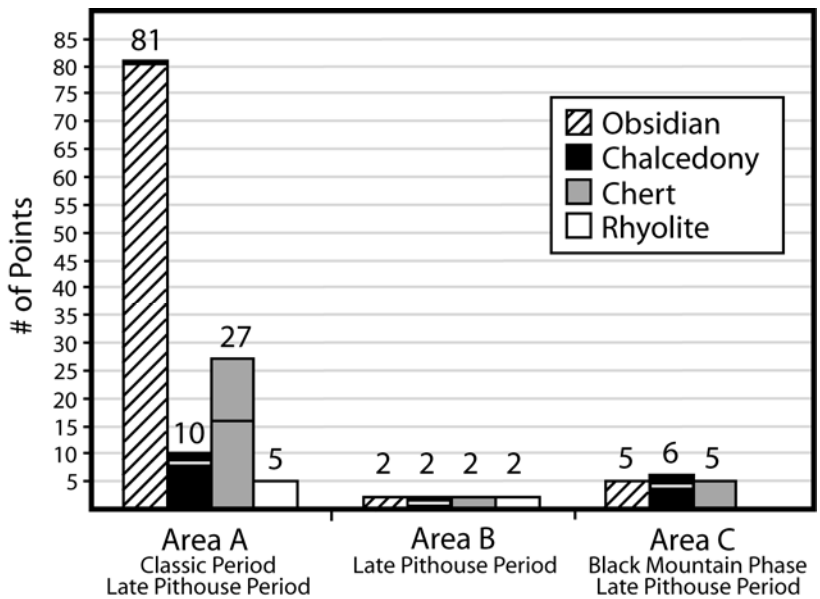


Figure 17: Number of points recovered form different excavation areas at Old Town that were fashioned from specified materials

From the information presented in Figures 16 and 17, it is possible to discern not only that obsidian was preferred over the other lithic materials, but that its preference culminated during the Classic period. Because Area A contained substantially more obsidian and chert than the other areas, and because Area A is the only area that contains a Classic period component, it could be argued that this preference was not constant and that it emerged during the Classic period. In order to test this tentative relationship, Chi-square calculations were conducted to see if there was a relationship between preferred lithic resource and excavation area. Table 7 shows the Chi-square calculation for the three excavation areas and the four lithic materials. The calculated Chi-square value for these samples is 24.0392 and is significant at the one percent significance level for six degrees of freedom (16.8119). Based on this information, there seems to be a relationship between the area / occupational phase and the type of lithic material that was procured for the manufacture of projectile points.

	Chert Pts.	**Chal. Pts.**	**Obs. Pts**	**Rhy. Pts.**	
Area A	29	10	81	5	125
Area B	2	2	2	2	8
Area C	5	6	5	0	16
	36	18	88	7	149
		Chi-Square			**24.03923**
0.05 significance level for 6 degrees of freedom					12.5916
0.01 significance level for 6 degrees of freedom					16.8119

Table 7: Chi-Square calculation for excavation areas and projectile point raw material

In order to determine what lithic resources were not related by chance, the Chi-square contingency was narrowed from the 3X4 of the computation above, to a 3X2 that measured the relationship between the three excavation areas and pairs of lithic materials. Table 8 shows the results of these calculations. Since the contingency table used to calculate these values was reduced, the degrees of freedom within the Chi-square calculation dropped to two. The determined significance level for two degrees of freedom at the five percent significance level is 5.99146, thus the calculated Chi-square values for the relationships among occupational area / phase and obsidian and rhyolite lithic resources (X^2 cal =

9.481184), and the relationship between occupational area / phase and obsidian and chalcedony lithic resources (X^2cal = 14.08846) are both of significance at the five percent significance level. From this information, it is clear that obsidian was being chosen over the other materials for the manufacture of arrow points.

Chalcedony and Chert	Chi-Square	3.02609
Chert and Obsidian	Chi-Square	3.336781
Chalcedony and Rhyolite	Chi-Square	3.445489
Chert and Rhyolite	Chi-Square	4.254546
Obsidian and Rhyolite	**Chi-Square**	**9.481184**
Chalcedony and Obsidian	**Chi-Square**	**14.08846**

Table 8: Chi-square calculation for excavation areas and paired lithic resources

The information gleaned from the 3X2 contingency table weighing the relationship between area / occupational phase and paired lithic resources was next refined so that paired lithic resources were weighed against paired areas / occupational phases and this information is presented in Table 9. This created a 2X2 contingency table and lowered the degrees of freedom to one, as well as lowered the calculated five percent significance level to 3.84146. From this, there appears to be a significant relationship between Areas A and B and obsidian and rhyolite lithic resources as well as a significant relationship between Areas A and C and obsidian and chalcedony lithic resources. This reflects a significant preference for obsidian over other lithic resources during the Classic period.

Chalcedony and Chert	0.8170283	0.024351	2.652814
Chert and Obsidian	0.8217463	0.034392	2.736319
Chalcedony and Rhyolite	0.4945055	3.75	2.426471
Chert and Rhyolite	2.8243867	3.214286	0.87236
Obsidian and Rhyolite	**8.5438356**	2.666667	0.292999
Chalcedony and Obsidian	3.7511059	0.116667	**12.19507**
	Area A-B	**Area B-C**	**Area A-C**
0.05 significance level for 1 degree of freedom			3.84146
0.01 significance level for 1 degree of freedom			6.6349

Table 9: Chi-Square values for two lithic materials and two excavations areas

This relationship presents itself when the distribution of the different projectile point types and raw material are plotted chronologically. Figure 18 shows the number and type of projectile points manufactured from differing materials with the points laid out in chronological order based on the evidence for NAN Ranch and Old Town. This figure shows the increased preference for obsidian as a material for producing projectile points coalescing with the Classic period arrow points.

The pattern of increasing preference for obsidian that has been revealed by this analysis is of interest because obsidian had to be acquired from distant sources. Figure 2, a map of obsidian sources within southwestern New Mexico, shows that the nearest sources, Mule Creek and Antelope Wells, are in excess of 90 kilometers from Old Town. Because these sources are at such a great

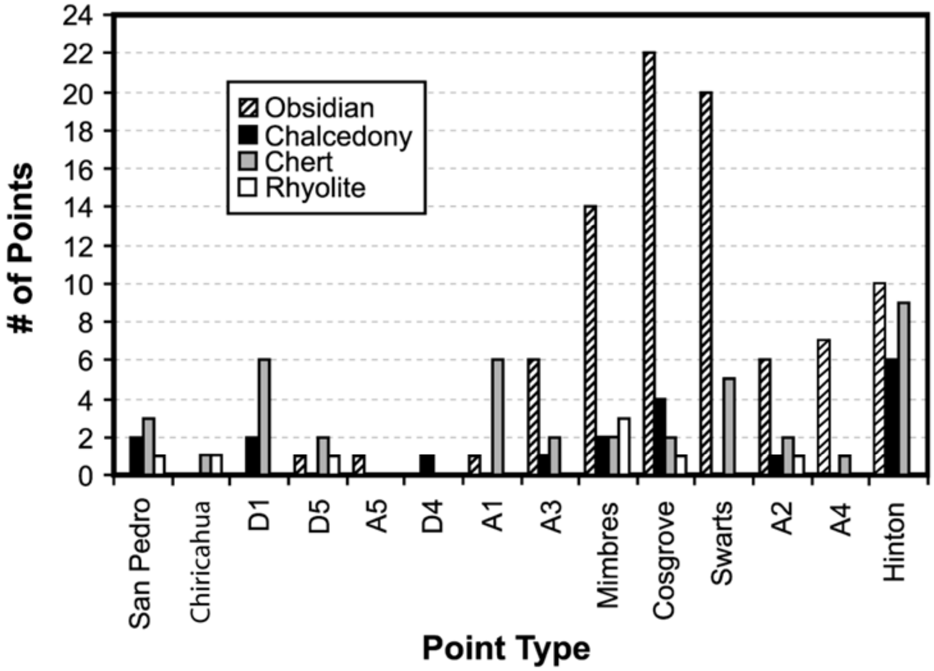


Figure 18: Number and Type of Projectile Points Manufactured from Differing Materials

distance from the site, and because the other suitable material was available within the immediate area, the Mimbreños' decision not only to produce the majority of their projectile points from obsidian, but also to go to such great lengths to obtain this material could be explained in many ways.

One possible explanation is that this pattern reflects the extreme importance of obsidian in these people's ideology. The presences of non-local exotic items within an assemblage is often interpreted in this manner. Another possible interpretation is that the pattern of increasing obsidian use is a consequence of the procurement of this material being embedded in subsistence activities. Thus when individuals seek to acquire food, they may also acquire raw material for making various objects. The pattern could be explained as a result of exchange for either finished projectile points or raw material used for their production. This material could have entered the region through an exchange system that dealt primarily with obsidian artifacts, or, because these artifacts are of such small size, they could have traveled alongside other exchange items. This pattern could also be the result of the Classic period Mimbres peoples' personal preference of obsidian over other raw materials for the manufacture of arrow points, and, as Fitting (1972) and other authors note, specific raw materials are often preferred for the manufacture of specific tool types. While obsidian has properties that make it ideal for the manufacture of chipped stone tools (e.g. brittleness and its ability to produce extremely sharp edges), the material still had to enter the region from distant source outcrops. To identify source areas for obsidian and to begin addressing how it may have entered into the Mimbres system, sourcing studies were conducted using laser ablation inductively coupled mass spectrometry.

Chapter VII: Chemical Compositional Analysis of Obsidian Artifacts

In order identify the source or sources of obsidian used by the residents of Old Town and the other sites, an extensive chemical compositional analysis was conducted. In addition, we anticipated that there may have been changes in the targeted obsidian sources through time.

Within the literature there are a plethora of studies that use various techniques to source different materials (e.g. Weigand et. al. 1977; Stephenson and McCurry 1990; Bradley 1993; Weigand and Harbottle 1993; Peterson et. al. 1997; Glascock et. al. 1998; Mallory-Greenough et. al 1998; Gratuze 1999; Devos et. al. 2000; Gratuze et. al 2001; Glascock 2002; Neff 2003; Shackley 1988, 1995, 1998, 1998a). Most of these studies utilize either Instrumental Neutron Activation Analysis (INAA), Energy Dispersive X-Ray Fluorescence (ED-XRF), or Inductively Coupled Plasma Mass Spectrometry (ICP-MS) as the means of chemical characterization. Instrumentation comparisons have been conducted for these different analytical techniques and show that these three methods produce comparable results, usually with elemental concentrations within ten percent of the other instrumentations' calculation (Glascock et. al. 1999, Gratuze 1999, Shackley 2004 personal communication).

The sample consists of the obsidian projectile points and some debitage from Old Town and certain other sites. In addition, I included the available projectile points from the Mimbres Foundation's 1970s survey of the Mimbres area and excavations at the Galaz and Mattocks ruins (courtesy of the Maxwell Museum at the University of New Mexico), the available projectile points from the Swarts ruin (courtesy of the Peabody Museum at Harvard University), and the projectile points from the NAN Ranch survey (courtesy of the Department of Anthropology at Texas A&M University). Chemical characterization studies were carried out using a Platform Inductively Coupled Plasma Mass Spectrometer in the Department of Geological Sciences at the University of Texas, Austin.

Inductively Coupled Plasma Mass Spectrometry (ICP-MS)

The development of inductively coupled plasmas (ICP) can be traced back to Tesla's experimentation with electrical fields (Greenfield and Foulkes 1999), but their utility with regards to elemental analyses was not realized until the 1960s when the research laboratories of Albright and Wilson Ltd, located in Oldbury, United Kingdom, developed a tunnel ICP through which a sample aerosol was injected and the resulting emission was recorded (emission spectrometry) (Greenfield and Foulkes 1999, Taylor 2001). Since these beginnings, various forms of spectrometry have emerged ranging from atomic emission spectrometry to atomic fluorescence spectrometry. It was not until the 1980s that researchers working with plasma torches that generated and maintained higher energy output, realized the tunnel ICPs could be utilized as an ionization source, and used the ICP torch to transport ions into a mass spectrometer.

Inductively Coupled Plasmas

Plasmas are “an electrically neutral gas made up of positive ions and free electrons (that) have sufficiently high energy to atomize, ionize and excite virtually all elements in the periodic table” (Taylor 2001). Inductively coupled plasmas are formed by combining both radio frequency generator power and an electromagnetic field with the neutral gasses to create a plasma. The electromagnetic field is created by running 700-1500W of power through a load coil that is wrapped around the plasma torch that creates an alternating current which maintains the frequency established by the radio frequency generator. The plasma torch is created by the insertion of electrons created by the spark produced by a Tesla coil into the gasses flowing near the load coil. Once the plasma is created, it is maintained by the process of inductive coupling, whereby the electrons used to initially create the plasma bombard the neutral gasses constituting the torch medium and produce additional electrons, this “cascading effect creates and sustains the plasma…as long as radio frequency power is applied to the load coil” (Taylor 2001). The plasmas created by this process reach sufficient temperatures to both completely break most elements down into individual atoms and ionize those atoms as well.

From the Sample to the Analyzer

Once the plasma is created there are multiple methods of sample induction. These methods are used on either solid or liquid samples, but the method known as laser ablation will be discussed here. Laser ablation is a method utilized for injecting portions of a solid sample by removing those portions with the aid of a laser. A combination of argon and helium gases flow through the chamber housing the solid specimen and when the laser ablates the surface of the sample it frees portions of its matrix. These portions are swept along by the gas flow and introduced to the plasma torch. Once the sample is introduced into the plasma, it is atomized, excited, ionized and passed through an interface, composed of a sampler and skimmer cone, that simultaneously samples the ions produced by the ICP and eases their transfer to the mass spectrometer by reducing the pressure of the environment through which the ions pass. The cones within the interface also serve to guide the ion beam's direction by making them pass through a series of ion lenses. Once through the lenses the ions are then passed through the quadropole mass analyzer, sometimes referred to as a quadropole mass filter / spectrometer, which consists of four cylindrical rods arranged parallel to one another in a symmetrical pattern with a space between the four of less than 10 microns (μm) through which the ion beam passes. The quadrapole mass analyzer is tuned by the researcher to measure isotopes with a specific atomic weight and then filters those isotopes not selected and allows those selected in the tuning process to pass unimpeded to the detector where their concentrations are measured.

Instrumentation Parameters

All artifacts were analyzed using the LUV 213 laser ablation sample induction system manufactured by New-Wave in tandem with a Platform ICP-MS manufactured by Micromass. All samples had material removed from their surface along a 2mm transect. These transects were first pre-ablated by a laser beam with a width of 125µm operating a 45% power. The pre-ablation process serves to clean the surface of the sample thus reducing the chances that material collected on the surface of the sample could interfere with the measurements calculated by the ICP-MS detector. Once the samples were pre-ablated, the gas flow of 1.3 liters per minute continued for a 15 seconds to purge the system of the pre-ablated material before the ablation pass was allowed to commence. The ablation pass passed over the sample at a speed of 25µm per second laying down a beam with a width of 100µm at 55% power. This material was then transferred to a quadrupole ICP-MS with a Daly-type detector. The quadrupole mass analyzer was tuned to filter 16 isotopes: 23Na, 27Al, 28Si, 39K, 41K, 44Ca, 49Ti, 55Mn, 56Fe, 85Rb, 88Sr, 89Y, 90Zr, 91Zr, 93Nb, and 138Ba. These isotopes were then transferred to the Daly-type detector that measured their concentrations.

Analytic Parameters

Before the samples were analyzed using LA-ICP-MS, the ICP-MS had to be calibrated to ensure that the selected isotope concentration measurements were correct. The calibration process consisted of allowing the plasma to warm up and stabilize for one hour before National Institute of Standards (NIST) Standard Reference Material (SRM) samples were run to make sure that the published concentrations corresponded to the concentrations being calculated by the ICP-MS detector. Five passes were conducted on each of the standards (NIST SRM 610, 612, and 614) with a blank run being conducted before and after each standard's analytic run. The published concentrations of these materials were then used to calibrate the readings obtained from the ICP-MS. Silicon was chosen as the internal standard by which the other data was to be normalized (Speakman et. al. 2002, Gratuze et. al. 2001, Gratuze 1999). A consistent silicon concentration was "divided by the actual number of counts" calculated by the detector to "produce a normalization factor from which all other elements in that sample can be multiplied" (Speakman et. Al. 2002: 52). The method known as blank subtraction was then conducted to finish the calibration process. This method uses a "blank" where concentrations are measured without the laser being fired. It thus provides a measure of the interference within the ICP-MS and by subtracting the blank from the concentrations calculated from analytic runs on the standards, a better approximation of the actual return signal from the standards can be established. The method calculates "a regression of blank-subtracted normalized counts to known elemental concentrations in the standards (and) yields a calibration equation that can be used to calculate elemental concentrations in the samples analyzed" (Speakman et. al. 2002, Gratuze et. al. 2001, Gratuze 1999). BCR 2G, a microbeam glass, was used as a quality control throughout the analyses to ensure that once the ICP-MS was calibrated that future measurements were correct.

Quantification

Once the ICP-MS was calibrated and the concentrations in parts per million (ppm) of the various isotopes had been collected for the samples, a combination of bivariate and multivariate analyses was used to assign an artifact to a source groups. Each of these samples was characterized using LA-ICP-MS to establish which source group the material came from. Elemental concentrations from the samples were exported to JMP 5.0 where these concentrations were grouped into Shackley's (1995, 2004) sources. This was accomplished by conducting discriminant analysis (DA) on the elements Ba, Rb, Sr, and Zr. This served two purposes. First, DA enables the recognition of separate groups based on the value of known groups; in this case, the known groups were those within Shackley's published data (1995,2004). Once the known clusters or groups are discerned, DA then groups unknown samples, our obsidian artifacts, to these known groups, based on an algorithm that calculates the distance to the nearest known group centroid. DA thus serves to discriminate between known groups and to classify unknown samples to known groups. The groups that were delineated using this method were within 10% of the measures of central tendency presented by Shackley (1995) with the exception of Fe, which could have resulted from an interference with SiSi+ within the ICP-MS.

Results

My sample consisted of 222 obsidian artifacts of which, 32, or 14.4% of the total assemblage, were recovered from the Galaz Ruin, three (1.4%) from the Mattocks ruin, 15 (6.8%) from sites located during the NAN survey, 139 (62.6%) from Old Town, five (2.3%) from the Powe Ruin, 24 (10.8%) from the Swarts Ruin, and four (1.8%) from miscellaneous sites within the valley. Figure 19 shows the location of these sites. The results of the multivariate statistical analysis are presented in Figure 20. Figures 21 and 22 show the results of the discriminant analysis.

Of the 222 samples, only one specimen came from the Antelope Wells source group and three were from the North Sawmill Creek subgroup of the Mule Creek source group. Four specimens, 1.8% of the total assemblage, were sourced to the Cow Canyon source group. Eight samples, or roughly 3.6% of all analyzed samples, were sourced to Gwynn Canyon, 122 (55%) were sourced to the Antelope Creek subgroup of the Mule Creek source group, 23 (10.4%) were sourced to the Mule Mountain subgroup of the Mule Creek source group, and 61 (27.5%) were grouped as having originated from material located within the San Francisco River Alluvium subgroup of the Mule Creek source group. From these data, we can ascertain that the major source the inhabitants of the Mimbres valley targeted for their obsidian was the Mule Creek source group in west central New Mexico (see Table 10 for this information in tabular format).

	Mule Creek Antelope Cr	Mule Creek Mule Mtns	Mule Cr/N Sawmill Cr	Mule Creek SF River Alluv.	Gwynn Canyon	Cow Canyon	Antelope Wells	Number	Percemt
Galaz	23	4		3	2			**32**	14.4
Mattocks		1		2				**3**	1.4
NAN Survey	4	1	2	6		1	1	**15**	6.8
Old Town	73	16	1	42	4	3		**139**	62.6
Poe	2			2	1			**5**	2.3
Swarts	20			4				**24**	10.8
Misc. Sites		1		2	1			**4**	1.8
Number	**122**	**23**	**3**	**61**	**8**	**4**	**1**	**222**	
Percent	54.95	10.36	1.35	27.48	3.6	1.8	0.45		

Table 10: Number of artifacts from each site that were sourced to a particular source groups and proportions of assemblages represented by materials from each archaeological site as well as those manufactured from obsidian originating at different source groups.

	Mule Creek Antelope Cr	Mule Creek Mule Mtns	Mule Cr/N Sawmill Cr	Mule Creek SF River Alluv.	Gwynn Canyon	Cow Canyon	Antelope Wells	Percent	Number
Galaz	71.88	12.5		9.38	6.25			100.01	**32**
Mattocks		33.33		66.67				100	**3**
NAN Survey	26.67	6.67	13.33	40		6.67	6.67	100.01	**15**
Old Town	52.52	11.51	0.72	30.22	2.88	2.16		100.01	**139**
Poe	40			40	20			100	**5**
Swarts	83.33			16.67				100	**24**
Misc. Sites		25		50	25			100	**4**

Table 11: Percentage of artifacts from each site that were manufactured from specific source materials

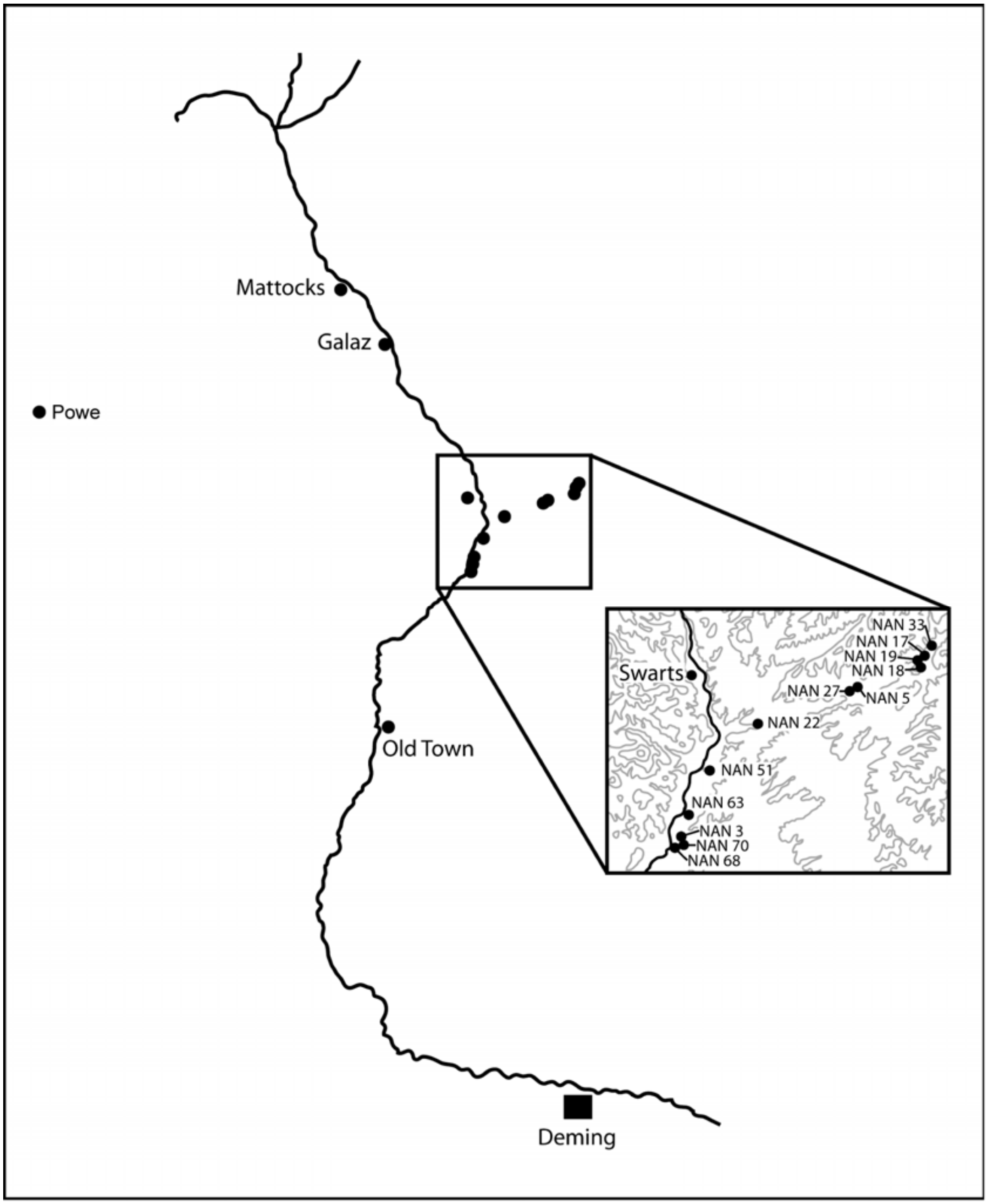


Figure 19: Name and location of sites from which obsidian samples were analyzed

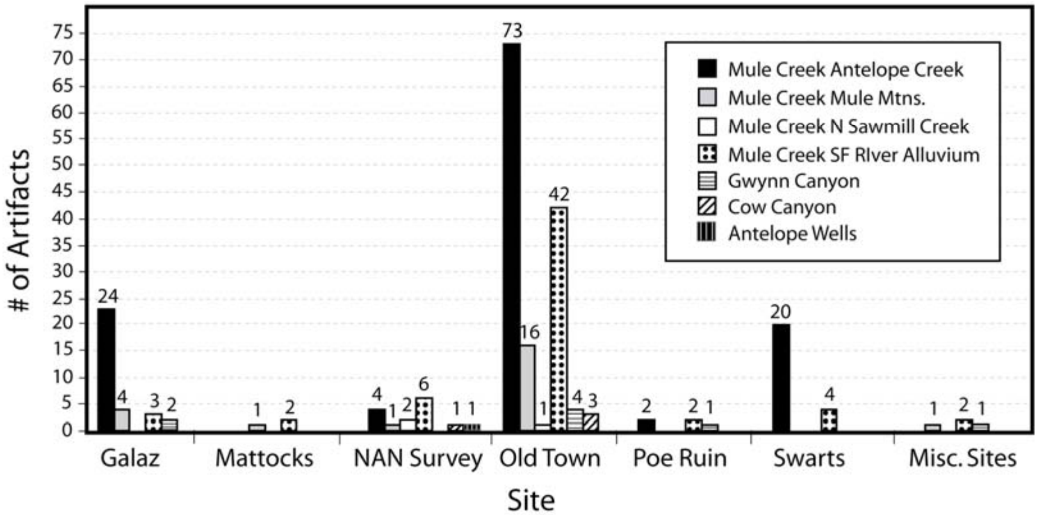


Figure 20: Number of obsidian artifacts recovered from different sites that were manufactured from specific source materials.

Figure 23 and Table 11 both show the percentage of artifacts from each site that were manufactured from obsidian originating at a specific source. Within the sample from the Galaz ruin assemblage (N=32), 71.9% of the artifacts originated from the Antelope Creek subgroup of the Mule Creek source group, 12.5% of the sample was produced from material obtained form the Mule Mountain subgroup of the Mule Creek source group, 9.4% came from material procured from the San Francisco River Alluvium subgroup of the Mule Creek source group, and 6.3% of the material came from the Gwynn Canyon source group. The three samples from the Mattocks ruin were obtained from the Mule Mountain subgroup (N=1) and the San Francisco River Alluvium subgroup (N=2) of the Mule Creek source group.

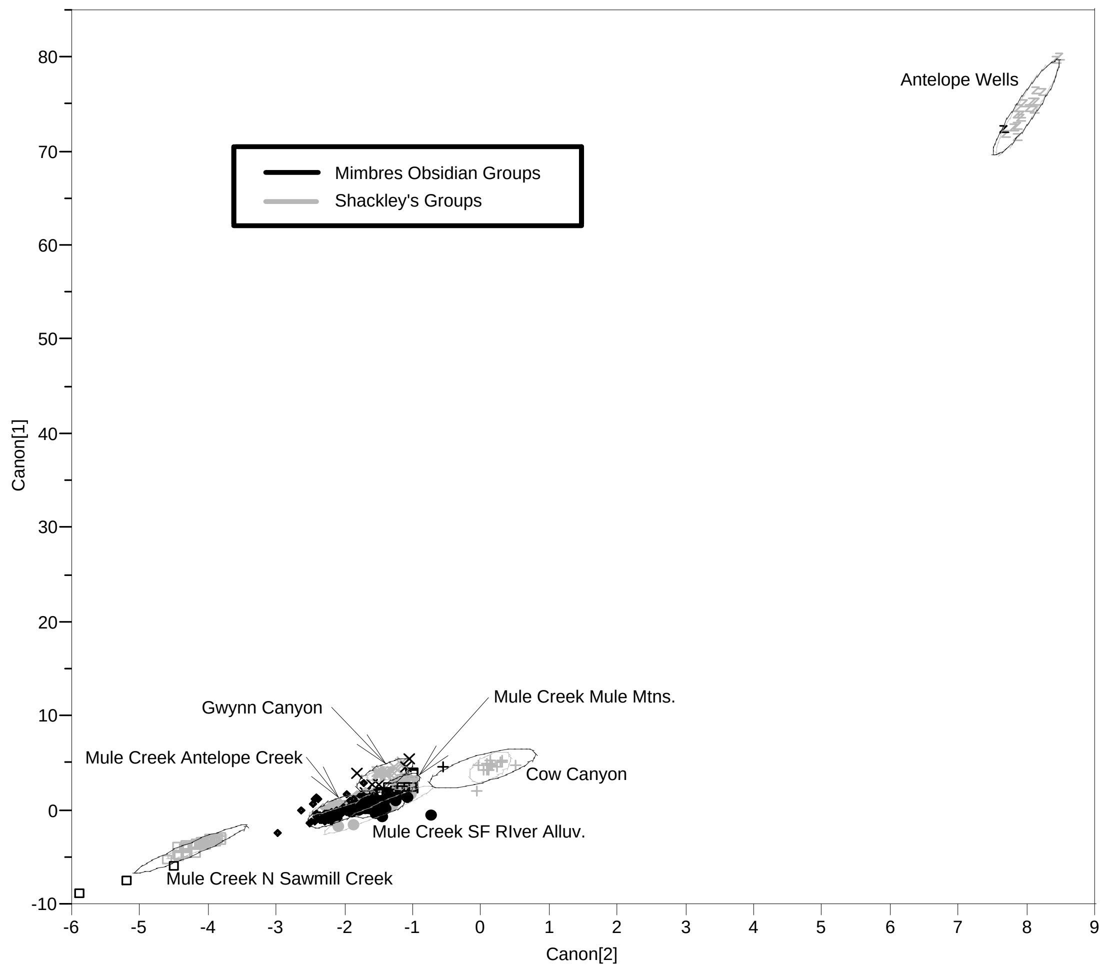


Figure 21: Results of discriminant analysis for all artifacts submitted to LA-ICP-MS characterization. Grey symbols represent Shackley's (1995, 2004) groups and black symbols represent artifacts from sites within the Mimbres Valley. Ellipses represent 90% probability of group membership.

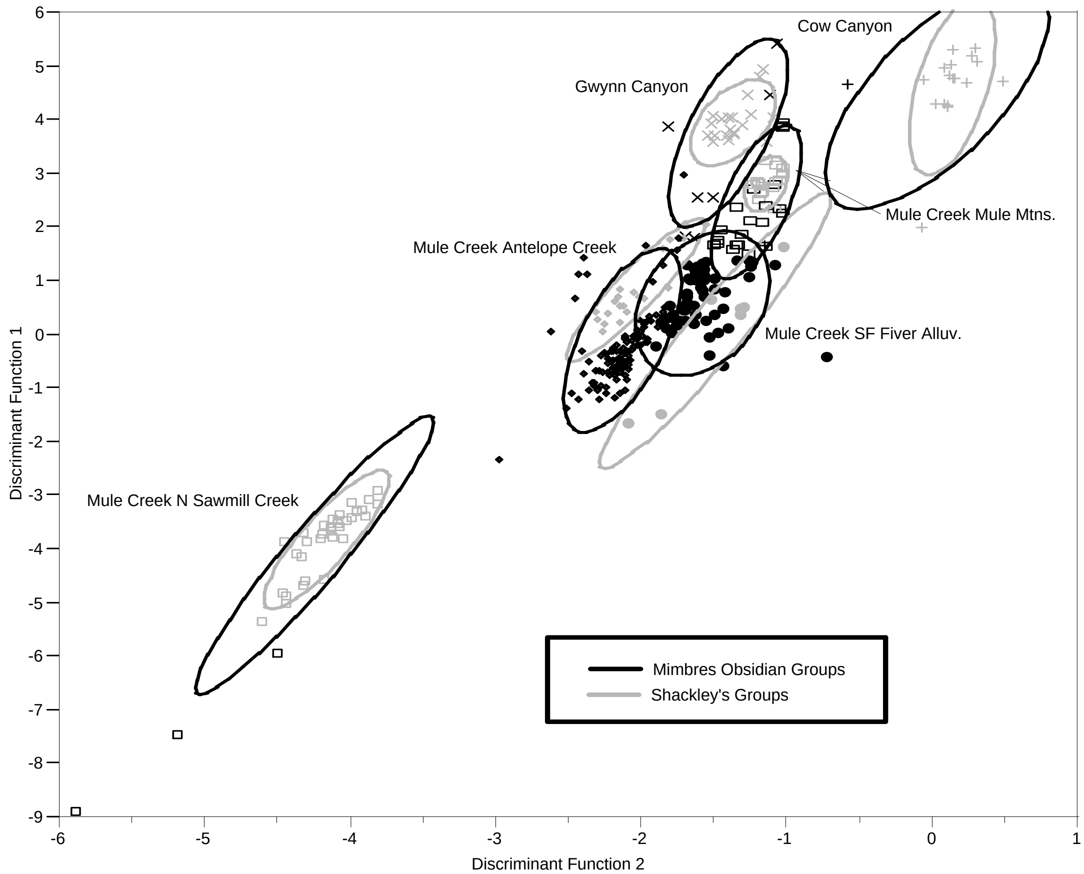


Figure 22: Results of discriminant analysis for all artifacts (minus the one sample from the NAN Survey material that was attributed to the Antelope Wells source group) Submitted to LA-ICP-MS Characterization. Grey symbols represent Shackley’s (1995, 2004) groups and black symbols represent artifacts from sites within the Mimbres Valley. Ellipses represent 90% probability of group membership.

The samples submitted from the NAN Survey project consisted of one piece of debitage from each of the 12 sites shown in Figures 11 and 19 as well as three medial biface fragments from NAN 18 and NAN 5. Of these, four were obtained from sources within the Antelope Creek subgroup of the Mule Creek source group (Tables 10 and 11), one was sourced as having been manufactured from material belonging to the Mule Mountain subgroup of the Mule Creek source group, two were fingerprinted to the North Sawmill Creek subgroup of the Mule Creek source group, six were obtained from material originating in the San Francisco River Alluvium subgroup of the Mule Creek source group, one of the samples came from material sourced to the Cow Canyon source group, and one was manufactured from Antelope Wells obsidian.

The sample from the Old Town ruin consisted of 139 artifacts, 83 of which were typable projectile points, 12 were untypable projectile point fragments, and 44 were debitage samples chosen using a stratified random sampling procedure. This procedure broke the site down into three strata, the main areas, and originally 20 random samples were to be chosen from each area using the excavation lot numbers assigned to each artifact. However, only four debitage samples were found in Area C, so a complete sample of this area's debitage was submitted for analysis. Areas A and B had a random sample drawn by importing all of the debitage lot numbers into SPSS 11.2 within which a random number list was generated from the lot numbers. From this random number list of lot numbers, the first 20 were chosen for analysis. This was done for both the Area A and Area B samples. Of the total Old Town sample, 73 were fashioned from material originating within the Antelope Creek subgroup of the Mule Creek source group (Tables 10 and 11), 16 of the samples were obtained from the Mule Mountain subgroup of the Mule Creek source group, one came from the North Sawmill Creek subgroup of the Mule Creek source group, 42 were manufactured from material belonging to the San Francisco River Alluvium subgroup of the Mule Creek source group, four sample were composed of Gwynn Canyon source group material, and three of the samples were manufactured from material originating at the Cow Canyon source group.

Five obsidian points from the Poe ruin were submitted for analysis. Of these two were sourced to the Antelope Creek sub-group of the Mule Creek source group (Tables 10 and 11), two were fashioned from material outcropping within the San Francisco River Alluvium sub-group of the Mule Creek source group, and one of the samples originated within the Gwynn Canyon source group.

Twenty-four obsidian projectile points from the Swarts ruin were analyzed. Of these 20 were fashioned from material originating within the Antelope Creek sub-group of the Mule Creek source group (Tables 10 and 11), and four of the samples were manufactured from material sourced to the San Francisco River Alluvium sub-group of the Mule Creek source group.

The remaining samples consisted of artifacts from sites collected during the Mimbres Foundation's survey of the Mimbres Valley. One artifact from each of the four sites (Z:5:10, Z:5:86, Z:13:16, and Z:13:21) was submitted for analysis. Of these samples, one artifact from Z:13:16 was sourced to material belonging to the Mule Mountain sub-group of the Mule Creek source group, two artifacts from the sample originated from material outcropping within the San Francisco River Alluvium sub-group of the Mule Creek source group and were recovered from the Z:5:86 and the Z:5:10 (Disert) sites, and one artifact recovered from Z:13:21 was fingerprinted as belonging to material from the Gwynn Canyon source group. Within each site, the relative proportion of both the Antelope Creek sub-group of the Mule Creek source group and the San Francisco River Alluvium sub-group of the Mule Creek source group stand out as composing the majority of each site's assemblage (Figures 23 and 24); and, as stated earlier, the larger Mule Creek source group composes the overwhelming majority of the assemblage. Of the 222 samples, the groups composing the Mule Creek source group make up roughly 94% of the assemblage, with samples manufactured from material obtained from the Gwynn Canyon source group, the Cow Canyon source group, and the Antelope wells source composing the remaining four percent (3.6%, 1.8%, and 0.5% respectively) (Figure 24).

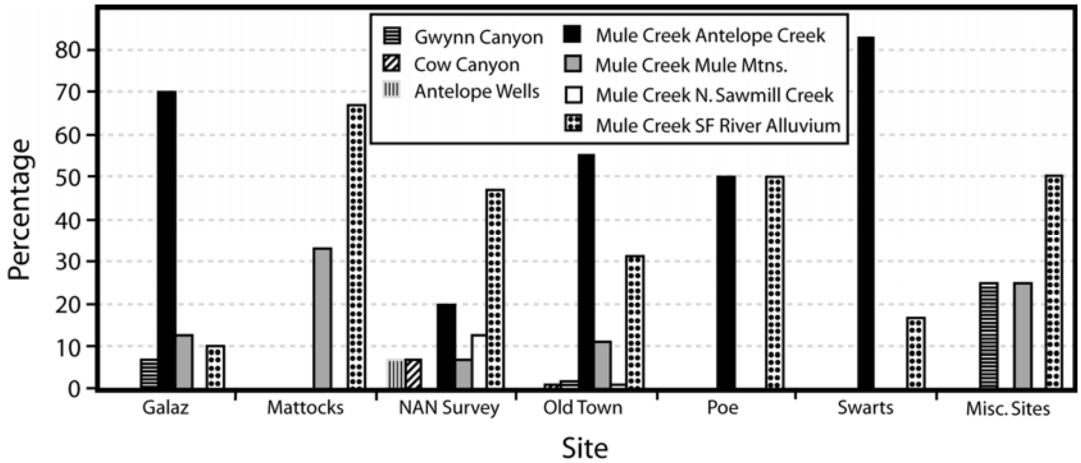


Figure 23: Percentage of artifacts from each site manufactured from different source material

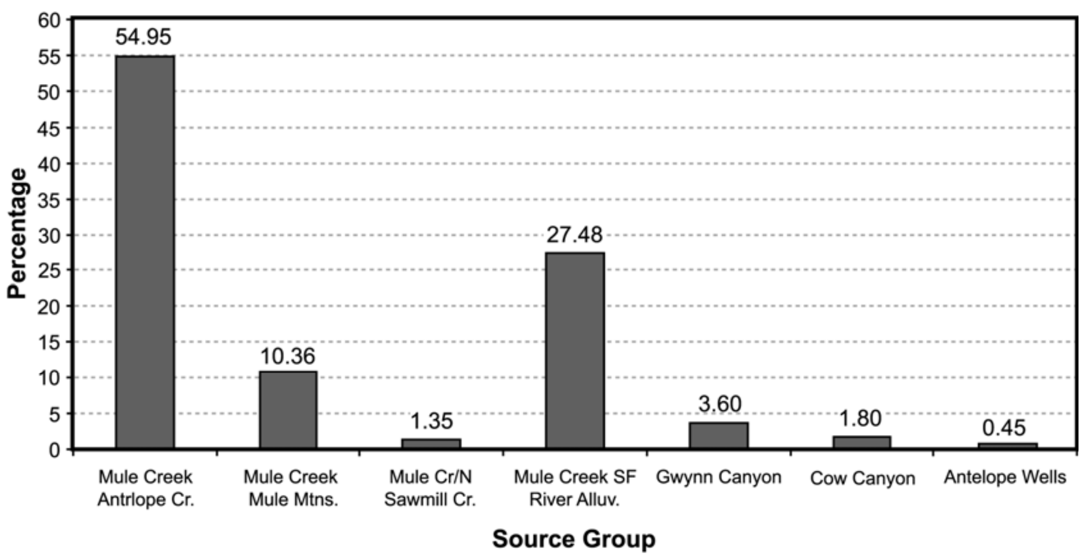


Figure 24: Percent of obsidian artifacts (N=222) manufactured from specified source material

Having established what obsidian source materials were being utilized by the inhabitants of the Mimbres Valley, the next step was to determine if there were shifts in which sources were utilized through time. This was accomplished by looking at what sources were utilized for the production of different point types. By looking at the information presented in Tables 5 and 6, it was possible to assign a temporal placement to each point type, and by looking at the source material utilized for the production of these particular point types, it was possible to assess what source materials were being utilized during the different temporal periods. Figure 25 shows the temporal placement of each point type as well as the number of each type that were manufactured from the different source materials. From this we can infer two things: 1), that the number of sources utilized by the Mimbreños changed little through time; and 2), that the transition from the Three Circle phase to the Classic period saw an increase in the number of points being manufactured out of obsidian.

During the San Francisco phase of the Late Pithouse period the primary obsidian sources were the Antelope Creek and Mule Mountain subgroups of the Mule Creek source group. This is obviously a result of a small sample size, and even if each of the points attributed to this phase were fashioned from different source materials, the maximum number of sources would be three. During the Three Circle phase of the Late Pithouse period, the number of obsidian sources

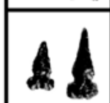
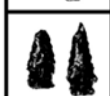
Period/Phase	Type	Points	Mule Creek Antelope Creek	Mule Creek Mule Mountain	Mule Creek North Sawmill Creek	Mule Creek San Francisco River Alluv.	Gwynn Canyon	Cow Canyon	Ratio of Obsidian : Other Raw Materials: Old Town	Ratio of Obsidian : Other Raw Materials: NAN Ranch
San Francisco Phase	D5		1						1 : 3	0 : 52
San Francisco Phase	A5		1	1					1 : 0	0 : 7
Three Circle Phase	D4			1					1 : 0	0 : 6
Three Circle Phase	A1		3						1 : 7	12 : 5
Three Circle Phase	A3		7	1		1	2		6 : 3	2 : 2
Three Circle Phase	Mimbres		9			3	1		14 : 7	16 : 17
Classic Period	Cosgrove		29	3	1	3			22 : 7	60 : 11
Classic Period	Swarts		24			3			20 : 5	41 : 18
Classic Period	A2		4	1			2	1	6 : 4	2 : 4
Classic Period	A4		3	2		1			7 : 1	7 : 0
Blk. Mtn. Phase	Hinton		4			4			10 : 15	20 : 3

Figure 25: Number of projectile points from each temporal period/phase that were manufactured from particular source materials

utilized by the Mimbres people was perhaps expanded to incorporate not only the other subgroups of the Mule Creek source group. We also begin to see the incorporation of material originating from the Gwynn Canyon source group to the west; and, as represented by a lone piece of debitage found at a Late Pithouse period site within Gavilan Canyon, Antelope Wells obsidian was also incorporated into the repertoire of known sources / exchange connections that emerged during the Three Circle phase. As time progressed, this trend of increasing manipulation of different source groups / exchange connections continued, and during the Classic period we see the incorporation of material from the Cow Canyon source group into this ever broadening procurement / social network. During the Black Mountain Phase source materials present in the preceding periods are also present. While the assignment of Hinton points to the Black Mountain phase is based on the presence of these point types within Area C at Old Town, they are also found in Terminal Classic contexts at the site. Thus, the presence of Mule Creek source materials within these contexts can be seen as a continuation of the manipulated social networks present in the Late Pithouse and Classic Periods. Also, one Hinton point sample from Disert (Z:5:10), a Cliff phase site, was sourced as belonging to the San Francisco River Alluvium subgroup of the Mule Creek source group. This suggests that Hinton points were either being manufactured at the Disert site, or that the inhabitants of Disert collected earlier points from another site and reused them.

Interpretation

In order to help understand the implications of this sourcing data, it would prove useful to contextualize this data set within the developments taking place during the transition to the Classic period, the developments taking place within the Classic period itself, and developments afterward. One of the most important developments was that of a marked population increase. The time between the beginning of the Early Pithouse period and the beginning of the classic period saw a substantial increase in population size, and even though some population estimates differ in regards to size, the basic pattern of a marked increase between Early Pithouse, Late Pithouse and Classic periods is evident (Minnis 1985, Blake et. al. 1986, Lekson 1992). Not only was there a marked increase in population, but a substantial development occurred within the Mimbreños' settlement pattern: population aggregation (Nelson 1993, 1999). Where the inhabitants of the Late Pithouse period were more dispersed, the populations of the Classic period chose to aggregate in larger numbers within fewer sites. This could have been bought about by the increased reliance on cultigens during the Late Pithouse period that continued to increase during the Classic period (Diehl 1996). The large populations cramming into fewer locales could have been a response to the marked population growth, in that aggregation would have increased the amount of cultivated land within the valley proper and along the valley's side drainages, thus allowing the subsistence demands of the increased population to be met. Of primary importance to the Mimbres people, then, was a stable environment, especially during the temporal span encompassed by the Late Pithouse and Classic periods. Dendroclimatological evidence (Minnis 1985, Lekson 1992) shows that during the Classic period the environment became increasingly unstable. Minnis (1985) argues that during this period of subsistence uncertainty the groups inhabiting the valley expanded their social networks to meet vital subsistence demands. By increasing vertical (hierarchical) and horizontal (extended kin) social relations in their network of social relationships, the Mimbres people were able to subsidize their production to meet their demands. This expansion of social networks is evident in the increasing array of exotic non-local items (i.e. shell, turquoise, obsidian, macaws, ceramics) within the material culture of the Classic period inhabitants (Bradley 1993, 2000; Weigand and Harbottle 1993; Creel and McKusick 1994).

It is within this context that the marked increase of obsidian consumption within the Mimbres Valley occurs. Minnis (1985) has shown that as the food stress brought about by the developments of the Classic period increased, individuals expanded the linkages within their social networks to meet vital subsistence demands. The social networks that were manipulated were those present within the preceding periods as is reflected by the obsidian source information from Pithouse period components. Because faunal remains indicate that sites within the Mimbres Valley were exploiting the natural environment immediately surrounding the communities (Cannon 2001, 2003), the procurement of these distant obsidian materials must be explained in a manner whereby lithic procurement is more than likely not embedded in direct (i.e. hunting parties) subsistence activities. Direct procurement of these materials, while a possible option, especially in secondary depositional contexts, seems unlikely due to the distances involved. The fact that materials might have possibly been acquired within a secondary context would not produce the proportional difference witnessed in the Classic period. Another reason direct procurement seems unlikely is that material suitable for the production of projectile points was readily available closer to home. In my opinion, procurement was embedded in the maintenance of social relations, and the increasing frequency of obsidian artifacts during the Classic period reflects the intensity with which these relations were utilized to buffer subsistence uncertainties.

In order to test these assumptions both ethnographic and ethno-historic data were studied to look at instances of raw material exploitation and the social contexts within which this exploitation was enmeshed.

Chapter VIII: Ethnographic Examples of Raw Material Procurement

Australia

Australian Aborigines of the Western Desert

In her analysis of the ethnographic record pertaining to stone tool production, Robin Torrence (1986) looked at both production and exchange, though she mainly focused on procurement and production in different societies to model her analysis of obsidian procurement within the Aegean. Her analysis utilized a number of ethnographic accounts of stone tool manufacture and shows that, as others have noticed, the ethnographic record is quite sparse with regards to accounts describing the production and exchange of lithic materials. In her discussion of Central and Western Desert Australian Aboriginal groups, she states that "consumers generally obtain their own raw material and manufacture their own tools for direct consumption" (1986: 51), thus these hunter-gatherer groups represent an example of direct procurement. Torrence bases her analysis of these Australian hunter-gatherer groups on Gould's ethnoarchaeological work describing quarrying activities within the area (Gould 1968, 1978, 1980; Gould et. al. 1971: in Torrence 1986), and concludes that the two quarry types described by Gould, surface outcrop quarry and below surface outcrop quarry, represent cases of direct access to the desired material. The activities that take place within the quarries focus on preparing cores and flakes to reduce the energy expenditure of acquisition and transport (Torrence 1986:52). Luedtke (1984) states a similar finding based on

Gould’s (1977) and Hayden’s (1977, 1979) work and states that most of the tools were manufactured at the quarries because it is here that the majority of the debitage is encountered (Gould 1977; Hayden 1977,1979: in Luedtke 1984). Gould (1978) states that the activities at the two types of quarries differ. The procurement locales that he terms a “quarry” are where cores and flakes are prepared and taken away for future reduction. At the location of surface accumulations, which he terms a nonquarry locality, or “gibber,” “stones were used as instant tools for activities on the spot” (1978:818). Gould also states that certain quarries, where preferred material outcropped, were often located at some distance from the village/community (in excess of one day’s walking distance) and that trips to these distance sources were often scheduled when the Aborigines’ supply was low (1978:830). It is of interest to note that, within the societies inhabiting the Australian Western Desert, stone tools made of “imported” materials were often seen as “relics” and carried “sacred significance” to the owner (1987: 831). Gould attributes the presence of these “imported relics” to the maintenance of social relations, he states:

> Marriage, totemic cult lodges, naming and other social relationships involving obligatory sharing are all consistent with the basic ecological requirement that people be able to move into distant, better favored areas and take up temporary residence with the people living in these places as a means of overcoming the economic uncertainties that act as limiting factors in the human settlement of the Western Desert (1978:832).

Northern Australian Aborigines (Ceremonial Exchange System)

Torrence (1986) uses the groups inhabiting the Arnhem Land of northern Australia as an example of social groups engaged in reciprocal exchange. Within this area, flint blades are produced at a quarry and are exchanged with groups, some at a considerable distance from the location of the blade's manufacture. Torrence's account is based solely on the ethnographic work of Donald Thomson (1949) who was interested in studying the ceremonial exchange system present within groups inhabiting Arnhem Land (Clark 1965: 17). Thomson "found on close investigation that every individual was born into a complex nexus of relationships that involved making gifts of goods to persons of different groups connected by marriage," and that within this system, goods could travel immense distances without any one individual having to traverse a large amount of space (Clark 1965: 17). The exchanges within this ceremonial exchange network were intensified during times when social solidarity was in need of intensification; these periods of intensification usually coincided with ceremonial events (i.e. rites of passage) within and between communities (Clark 1965). As Clark notes, "thus the gift cycle emphasized the solidarity of particular groups, while at the same time maintaining good relations with neighboring ones" (Clark 1965: 17). The one item that Clark lists as an example of those that moved within the system was projectile points.

Stone Axe Blades

Torrence states that the production and distribution of greenstone axe blades is an example of a balanced, reciprocal exchange network. This conclusion is based heavily on the work of Isabel McBryde (1978; 1979; Binns and McBryde 1972; McBryde and Watchman 1976; McBryde and Harrison 1981). McBryde's work, which focuses on the Lancefield quarries, near Melbourne, has shown that there was an extensive trade network whereby these greenstone axes sometimes moved in excess of 100 miles. Particular social groups claimed ownership over the quarries from which greenstone outcrops and only certain members of a particular family were allowed to work the quarries. The type of sanctions placed on an individual who transgressed the ownership tenure of a social group are unknown, and the quarry owners only worked the site when neighboring groups requested finished axes. When such a request was given, the requesting group came and camped near the quarry at which point the group claiming ownership rights to the quarry would meet with the incoming group and exchanges would be made once the greenstone axe blanks were fashioned (Clark 1965). McBryde notes "rugs, weapons and ornaments were exchanged for it, three pieces of stone for one possum skin rug" (McBryde 1978:364 in Torrence 1986:56). Torrence states that neighboring tribes could also acquire their greenstone axes through ceremonial exchange that occurred at special centers some distance from the quarry locality. All of this ethnographic data is based on Howitt's 1904 observations and postdate the final occupation of the Lancefield quarries by roughly 50 years (Clark 1965).

Melanesia

New Guinea

Like the Australian Aborigines who harvested greenstone from the Lancefield quarries near Melbourne, the inhabitants of Papua New Guinea also produced stone axes. But unlike the Australian case, the New Guineans produced three different axe types that are used in different social contexts (Torrence 1986: 57). Individuals, presumably men, who lived near a suitable source material fashioned stone axes for either themselves, or to meet the demands of the local community in exchange for different goods (Torrence 1986:57). Of the three different axe types, the quarries with source material capable of producing the largest axe type, ceremonial axes, are the most prized, and would sometimes come under the tenure of particular social groups. Malonowski (1934) noted that these unusually large, finely crafted, and from a functional standpoint, useless axes served as a form of wealth and marked the prestige of leaders within a community. Blanks were fashioned at the quarry and the final polishing would take place at another location with suitable resources to grind the blank's surfaces smooth (Torrence 1986, Clark1965). Clark (1986) notes that when Seligman visited the area during the first decades of the 20th century, that most of the raw material was first procured from either Murua Island or Woodlark Island and then the rough blanks were traded to either the Marshall Bennett Islands or the Trobriand Islands where they would have been polished into a finished product. Salisbury (1962) states that these axes were commonly exchanged for food and salt, and as in the Australian ceremonial exchange system, the presence of kin relations with neighboring communities eased the passage of goods between social groups (Salisbury in Clark 1965: 20).

North America

The ethnographic record dealing with groups residing in the southwestern United States is vast. But, like Torrence and other scholars noted for ethnographic accounts of stone tool production, the amount of material pertaining to raw material exploitation in these studies is sparse. The Hopi and Zuni Indians have a long history within the region, but developments taking place within the late A.D. 1300s have led to their current settlements in east central Arizona and west central New Mexico respectively. While it is recognized that many changes have occurred within this society since that time, I feel it useful to analyze ethnographic accounts of raw material exploitation within these two societies. Again, the main purposes are to look at the social contexts in which this exploitation is carried out, to look a the social contexts in which exchange takes place, and to look at what materials are being transferred during these transactions.

Hopi Indians

In his account of the Hopi groups of Old Oraibi, Titiev gives various accounts of different materials procurement. Wood, which has been of importance to all Native American groups within the area, was often procured by the Hopi Indians through trade or either through direct procurement of the resource (Titiev 1944, 1972). When direct acquisition of this material was being carried out, the forays into Navajo country to acquire piñon could take several days even with the aid of automobiles (Titiev 1972: 50-51, 63-64).

Another item of central importance to the Hopi Indians was the Piki stone (griddle stone). These items were quarried from deposits about 12 miles south of Oraibi and were only quarried under a rigid set of cultural customs. If a woman was in need of a new Piki stone, she would ask one of her male relatives to lead an expedition to the quarry in order to obtain one. If the male relative acquiesced and agreed to lead such an expedition, he would make his intention public knowledge during the Soyal ceremony and make preparations for the journey to the quarry, which would occur during Autumn or Spring. Others in need of a Piki stone would meet the expedition's leader before he set out for the quarry, at which point the leader would tell the party how many days he was going to be in charge of the expedition. Once this information was disclosed, the leader set out for the quarry ahead of the others and constructed a shrine at the quarry site to house the prayer offerings of those Hopis coming to the site to obtain Piki stones. When the party members arrived at the Piki quarry, they handed their prayer offering to the party leader who then placed the offering within the shrine, and the party member then scoured the quarry for a suitable stone (Titiev 1944: 197).

Another resource that is highly prized by Hopi groups is salt. There are two salt sources that are traditionally visited to procure this resource: Zuni Salt Lake in New Mexico, and Salt Canyon near the Grand Canyon. Like the Piki stone example, if a salt gathering expedition is being planned "arrangements must be made during the Soyal observances" (Titiev 1944:142). As Talayesva (1944) shows, the arduous 22 day journey to Salt Canyon is peppered with religious observances along the way (Titiev 1972: 64).

In the ethnographic record of the Hopi Indians, most accounts indicate that exchange transactions take place within a ceremonial context where goods are distributed by ceremonial performers to the crowds gathered within the plaza areas. Numerous items including katchina dolls, bows, arrows, food, and toy rattles are distributed in this manner (Titiev 1944, 1972). Because different social groups within Hopi society are responsible for the production of different ceremonies, goods are redistributed throughout Hopi society. There are also ethnographic accounts of exchange between the Hopi and different Native American southwestern groups. These exchange relations take the form of friendship obligations such that when a Navajo, Hopi, or Zuni Indian visits the community of another, they go directly to their friend's residence and leave a gift (e.g. mutton, rug, piñon nuts, jewelry) in return for room and board throughout their stay in the community. In addition, gifts are made of items such as bread, corn, or melons when their friend departs (Vogt and Albert 1966: 50).

Zuni Indians

In many ways, the ethnographic record for the Zuni Indians is similar to that of the Hopi with regards to examples of raw material utilization and exchange interactions in that the exploitation of wood, salt, and lithic material for the production of Hel'-äsh-na-k'ia stones (the Zuni equivalent of Piki stones) have received the majority of ethnographers' attention. The ethnographic record for the Zuni Indians also parallels that of the Hopi in that the majority of exchange interactions noted by various ethnographers are those that center on transactions taking place as a result of ceremonial obligations.

Zuni Hel'-äsh-na-k'ia stones are fashioned from a gray sandstone that is quarried at the base of Corn Mountain some three miles east of Zuni. Differing accounts of the production of these griddle stones exist and could represent changes in Zuni culture. In Cushing's (1920) study of Zuni Breadstuff, he states that the Zuni women were responsible for the extraction of the raw material from the quarry, the polishing of the quarry blank, and the ceremonies associated with producing a finished product (Cushing 1920:217-327). However, Stevenson's (1904) account of the production of Hel'-äsh-na-k'ia stones describes the quarrying of the material as being done by men and that once the quarry blank is brought back to Zuni, women take control of the process and finish its production (1904: 361). In either case, the material is procured directly. Stevenson also notes that building stone for houses is also directly procured from a quarry a few miles from Zuni.

Zuni salt procurement is first initiated in July when the Rain Priests gather to arrange for the annual journey. The morning after the Rain Priests meet, the Bow Priest announces that anyone in need of salt needs to be ready to make the trek to the Zuni Salt Lake in four days (Stevenson 1904: 354-361). Like the Hopi journey to Salt Canyon, the Zuni journey to the Zuni Salt Lake, some 42 miles south of Zuni, was at times a treacherous ordeal and is imbued with sacred connotations (Ferguson and Hart 1985).

Ceremonies that take place within the plaza areas at Zuni serve to redistribute materials within society. Copious amounts of goods are distributed by those taking part in the ceremony to the crowds watching within the plaza area. Like the Hopi, different Zuni social groups are responsible for the different ceremonies, so each social group will have their turn at distributing goods throughout the whole of Zuni society.

Chapter IX: Conclusions

Based on the ethnographic data concerning stone tool production it can be inferred that: 1) the exchange of lithic materials sometimes accompanies the exchange of subsistence goods, and that this exchange intensifies during times of economic stress; 2) exchange of any product solidifies social bonds and the relationships most often utilized with the exchange of lithic products are kinship relations; and 3) seemingly utilitarian lithic artifacts are often imbued with ceremonial significance such that the exchange of these goods sometimes takes place within a larger symbolic system. All of these inferences come from examples where procurement strategies differ, and even Torrence's seemingly clear-cut example of direct procurement with the Australian Aborigines of the Western Desert has implications for exchange. Though she doesn't focus on what happens after the material is quarried, the fact remains that non-local materials manage to surface within these social groups.

Because little research has been conducted to assess the procurement strategies of the Mimbres Mogollon other than saying that material was not directly procured, acquisition and production of these presumed exchange goods is poorly understood. Shackley (1995, 2004) gives accounts of bipolar detritus being encountered at each of the source materials, but states that there is no evidence indicative of intensive exploitation, namely architectural remains or any artifact other than obsidian debitage. This suggests that, somewhat like the stone axe examples within the ethnographic record, limited reduction took place at the source.

Another possible reason for the lack of more substantial evidence of resource exploitation is that the type of materials being traded changed through time. For example, during this study, while searching for Old Town debitage samples that could be confidently attributed to the Classic period, it became apparent that no obsidian debitage was present within stratified deposits which contained other kinds of Classic period refuse. This contrasts sharply with the Late Pithouse period in which obsidian debitage is commonly found in well stratified deposits. This suggests that during the Late Pithouse period some, if not all, of the obsidian coming into the area was in its raw “Apache Teardrop” nodular form and was reduced to finished form within Old Town; the same is true of other sites in the area (Dockall 1991). However, because of the apparent absence of obsidian debitage in Classic deposits at Old Town, it seems probable that finished products, or at least partially finished products, were being manufactured elsewhere and distributed to other communities like Old Town for consumption.

This leads me to hypothesize three possible models of lithic procurement that were effective during the transition from the Late Pithouse period to the Classic period. The first of these is that direct procurement was taking place during both the Late Pithouse period and the Classic period but that the inhabitants during the Late Pithouse period were collecting obsidian nodules and bring them back to the community for reduction whereas the inhabitants of the Classic period were reducing the nodules at the source and transporting either preforms or finished points back to the community. The second hypothesis is that exchange was taking place during both the Late Pithouse period and the Classic period, but the former centered on exchange of raw material whereas the later focused attention on finished products or preforms. The third and final hypothesis is that during the Late Pithouse period the Mimbres people procured their obsidian directly and that this changed during the Classic period, when the inhabitants of the Mimbres valley began to obtain their obsidian through exchange networks with groups living closer to the source material.

Analyzing these hypotheses is difficult for a number of reasons, but the most significant of these is that to fully assess the lithic production sequence at a site, all stages of tool manufacture must be collected. Most researchers in North America implement a sampling strategy that utilizes a ¼" screen to collect material, and while this recovers the majority of the specimens present within the reduction sequence, small bifacial thinning flakes and pressure flakes usually pass through the screen. This was the sampling strategy utilized during the Old Town excavations, although some selected features' fill was fine screened. Thus, in assessing whether or not finished points or preforms were coming into the area during the Classic period, vital information is missing, thus constraining analysis of this and other issues pertaining to the lithic technology of the Mimbres Mogollon.

Within this study, it was assumed that if bipolar detritus is present, bifacial thinning flakes are present as well. While this assumption leads to the conclusion that most stages within the reduction sequence are present within Late Pithouse period components at Old Town, because of the uncertain temporal ascription of artifacts recovered from non-stratified deposits in Area A and Area C, the exact nature of production taking place at Old Town during the Late Pithouse, Classic, and Black Mountain periods / phase is conjectural.

Despite these biases in the data, I feel that exchange was taking place during both the Late Pithouse and Classic periods and possibly during the Black Mountain phase. More specifically, during the Late Pithouse period raw materials were being imported into the Mimbres area, and during the Classic period, finished tools or preforms were being brought into the region. This conclusion is based both on the distances that would have been involved in direct procurement, and the fact that debitage indicative of bipolar reduction is found at Late Pithouse components at Old Town. As previously stated, the debitage found in both the Classic and Black Mountain components at the site cannot be confidently attributed to those periods. When assemblages from stratified deposits were investigated, they yielded no artifacts indicating that obsidian reduction took place during the Classic period or the Black Mountain phase.

Mass debitage analyses from the NAN Ranch ruin showed that there was shift in raw materials being exploited by the site's inhabitants through time

(Dockall 1991). This shift was most apparent during the transition from the San Francisco phase to the Three Circle phase, and represents a change from procurement of more fine-grained materials (i.e. chert, chalcedony, and obsidian) to procurement of predominantly coarse grained materials (i.e. rhyolite and andesite) which are more readily available within the immediate surroundings at NAN (Dockall 1991:128-140). Within this pattern, however, obsidian procurement increases through time, from being virtually nonexistent in the Georgetown and San Francisco phases, to composing about two percent of the debitage assemblage in the Three Circle phase, and decreasing within Classic period contexts (Dockall 1991: 128-140). If a similar pattern was present at both NAN and Old Town, where many of the deposits are mixed, then the data could indicate the presence of obsidian nodules coming into the region during the Late Pithouse period followed by the importation of finished products or preforms during the Classic period.

How does the obsidian data from the Mimbres area correspond with data from other portions of the “Mimbres regional system” (Shafer 2003)? Data from Luna and Reserve areas of the Mogollon Highlands show a similar pattern where the majority of the assemblage consists of obsidian obtained from the Antelope Creek and Mule Mountain subgroups of the Mule Creek source group, with lesser amounts of Cow Canyon, Gwynn Canyon and Red Hill source materials (Shackley 1999a, 1999b, 1999c). The presence of the Red Hill source group within these assemblages is to be expected due to their closer proximity to the source. Hayden

(1999) notes that within the area there is a shift in the amounts of obsidian present within the lithic assemblage through time, and this shift is the opposite of the one discerned for the Mimbres area. During the Archaic and up through the Late Pithouse period, obsidian become an increasing part of the assemblage, peaking at 8.5% of the assemblage in the Late Pithouse period. Then, during the Pueblo period, the percentage of obsidian within the lithic assemblage drops to 2%. However, it is during the “Early and Late Pueblo” periods that importation of ceramics manufactured in the Mimbres Valley peaks, while obsidian is utilized less in the production of chipped stone tools (Hayden 1999: 202). Moiola (1999) shows that production was taking place at sites within the Mogollon Highlands and that both core flakes and biface flakes were present, indicating that the inhabitants of the Reserve and Luna areas performed some reduction on site.

Obsidian sourcing data from the Late Pithouse period Florida Mountain site (LA18839) near Deming shows that the major source was the Sierra Fresnal source group in northern Chihuahua. Lesser amounts of Mule Creek, Antelope Wells, Los Jagueyes, Mount Taylor, and Florida Mountains obsidian were present at the site (Shackley 2004a). Pye (2004) noted that little debitage was collected from the site and concluded that the obsidian was obtained either from exchange with groups living near the sources or directly from secondary sources during the group’s seasonal rounds. While both options are possible, Pye (2004) leans more towards finished tools making their way into the site via exchange relations. As he notes, the relative scarcity of debitage at the site could be accounted for through the sampling biases or through the importation of finished products or performs in to the area.

Obsidian sourcing studies from Mimbres sites in the nearby Cedar Mountains show a similar patter. The majority of the obsidian originated at the Sierra Fresnal source group, with lesser amounts of material from the Antelope Wells, Mule Creek, and Cow Canyon sources (Shackley 2002).

Together, these sourcing studies suggest that different patterns are present within the southern portions of the Mimbres regional system, the Mimbres Valley, and the Mogollon Highlands near Reserve. Within the Mogollon Highlands, direct acquisition of obsidian could have taken place, but due to the distances involved (100km), exchange is preferred as the probable means of acquisition. Settlements in the Mogollon Highlands contain a relatively substantial amount of production detritus and could represent a finishing locale for raw materials coming in from the Mule Creek source groups. The decline in the number of obsidian artifacts present in the Pueblo period within the Mogollon Highlands, coupled with the increased presence of Mimbres Valley ceramics and the increase of obsidian artifacts within Classic period sites in the Mimbres Valley, leads to the tentative conclusion that obsidian tools made in the Mogollon Highlands were moved from the northern areas to the Mimbres Valley and beyond, with ceramics moving in the opposite direction.

A different pattern seems to present itself for the southern portions of the Mimbres regional system. This area seems to have established social relations with people to the south in Chihuahua. These relations, while apparent in the obsidian data, were not the only ones in place. Obsidian was also coming from northern and western sources. It is possible that the Mule Creek specimens found in the area made their way by down-the-line trade originating with groups in either the Mogollon Highlands or the Mimbres Valley. Whatever the scenario, the relations between Mimbres Valley inhabitants and southern Mimbres people were important, especially during the Terminal / Postclassic period and the following Black Mountain phase.

References Cited

Adams, Jenny L.
2002 *Ground Stone Analysis: A Technological Approach*. The University of Utah Press, Salt Lake City.

Andrefsky, William Jr.
2001 Lithics: Macroscopic Approaches to Analysis. *Cambridge Manuals in Archaeology*. Cambridge University Press, Cambridge, UK.

Anyon, Roger, Patricia A. Gilman and Steven LeBlanc
1981 A Reevaluation of the Mogollon – Mimbres Archaeological Sequence. *The Kiva* 46:209-225.

Anyon, Roger and Steven LeBlanc
1980 The Architectural Evolution of Mogollon – Mimbres Communal Structures. *The Kiva* 45:253-277.

Anyon, Roger and Steven LeBlanc
1984 *The Galaz Ruin: A Prehistoric Mimbres Village in Southwestern New Mexico*. By Roger Anyon and Steven LeBlanc. Maxwell Museum of Anthropology and the University of New Mexico Press, Albuquerque, New Mexico.

Blake, Michael, Steven A. LeBlanc, and Paul E. Minnis
1986 Changing Settlement and Population in the Mimbres Valley, SW New Mexico. *Journal of Field Archaeology* 13:439-464.

Binford, Lewis R.
1972 *An Archaeological Perspective*. Seminar Press, New York.

Binford, Lewis R.
1979 Organization and Formation Processes: Looking at Curated Technologies. *Journal of Anthropological Research* 35:255-273.

Binns, R. A. and I. McBryde
1972 *A Petrological Analysis of Ground-edge Artefacts from Northern New South Wales*. Australian Institute of Aboriginal Studies, Canberea.

Bradfield, Wesley
1929 *Cameron Creek Village: A Site in the Mimbres Area in Grant County New Mexico*. Monographs of the School of American Research No. 1, Santa Fe.

Bradley, Ronna J.
1993 Marine Shell Exchange in Northwest Mexico and the Southwest. In *The American Southwest and Mesoamerica: Systems of Prehistoric Exchange*, edited by Jonathon E. Ericson and Timothy G. Baugh pp. 121-158. Plenum Press, New York.

Bradley, Ronna J.
2000 Networks of Shell Ornament Exchange: A Critical Assessment of Prestige Economies in the North American Southwest. In *The Archaeology of Regional Interaction: Religion, Warfare, and Exchange Across the American Southwest and Beyond*, Proceedings of the 1996 Southwest Symposium, edited by Michelle Hegmon pp.167-187. University Press of Colorado, Boulder.

Cameron, Catherine M.
2001 Pink Chert, Projectile Points, and the Chacoan Regional System. *American Antiquity*, 66(1): 79-102.

Cannon, Michael D.
2001 *Large Mammal Resource Depression and Agricultural Intensification: An Empirical Test in the Mimbres Valley, New Mexico*. Ph.D. Dissertation, University of Washington, Seattle.

Cannon, Michael D.
2003 A Model of Central Place Forager Prey Choice and an Application to Faunal Remains from the Mimbres Valley, New Mexico. *Journal of Anthropological Archaeology*, 22:1-25.

Clark, Grahame
1965 Traffic in Stone Axe and Adze Blades. *The Economic History Review,* Essays in Economic History Presented to Professor M. M. Postan 18(1):1-28.

Cordell, Linda S.
1997 *Prehistory of the Southwest*. Second edition, Academic Press, Orlando.

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

Cosgrove, H. B. and C. B. Cosgrove
1932 *The Swarts Ruin: A Typical Mimbres Site in Southwestern New Mexico*. Report of the Mimbres Valley Expedition Seasons of 1924-1927. Papers of the Peabody Museum of American Archaeology and Ethnology, Harvard University, Vol 15, No. 1. Cambridge, Massachusetts.

Creel, Darrell G.
1986, 1987 Gavilan Canyon Survey Notes. Notes on file at Texas Archaeological Research Laboratory.

Creel, Darrell G.
1989 A Primary Cremation at the NAN Ranch Ruin, with Comparative Data on Other Cremations in the Mimbres Area, New Mexico. *Journal of Field Archaeology* 16(3):309-329.

Creel, Darrell G.
1991 *Status Report on Excavations at the Old Town Site (LA1113), Luna County, New Mexico, Summer 1991*. Report submitted to the U.S. Bureau of Land Management, New Mexico State Office, by the Texas Archaeological Research Laboratory, University of Texas at Austin.

Creel, Darrell G.
1993 *Status Report on Excavations at the Old Town Site (LA1113), Luna County, New Mexico, Summer 1993*. Report submitted to the U.S. Bureau of Land Management, New Mexico State Office, by the Texas Archaeological Research Laboratory, University of Texas at Austin.

Creel, Darrell G.
1995 *Status Report on Excavations at the Old Town Site (LA1113), Luna County, New Mexico, Summer 1995*. Report submitted to the U.S. Bureau of Land Management, New Mexico State Office, by the Texas Archaeological Research Laboratory, University of Texas at Austin.

Creel, Darrell G.
1997 *Status Report on Excavations at the Old Town Site (LA1113), Luna County, New Mexico, Summer 1997*. Report submitted to the U.S. Bureau of Land Management, New Mexico State Office, by the Texas Archaeological Research Laboratory, University of Texas at Austin.

Creel, Darrell G.
1998 *Status Report on Excavations at the Old Town Site (LA1113), Luna County, New Mexico, Summer 1998.* Report submitted to the U.S. Bureau of Land Management, New Mexico State Office, by the Texas Archaeological Research Laboratory, University of Texas at Austin.

Creel, Darrell G.
1999 *Status Report on Excavations at the Old Town Site (LA1113), Luna County, New Mexico, Summer 1999.* Report submitted to the U.S. Bureau of Land Management, New Mexico State Office, by the Texas Archaeological Research Laboratory, University of Texas at Austin.

Creel, Darrell G.
1999a The Black Mountain Phase in Mimbres Archaeology. In *The Casas Grandes World*. The University of Utah Press, Salt Lake City.

Creel, Darrell G.
2005 Old Town Site Report. Manuscript in possession of the author.

Creel, Darrell G. and Charmion McKusick
1994 Prehistoric Macaws and Parrots in the Mimbres Area, New Mexico. *American Antiquity* 59(3):510-524.

Creel, Darrell G., and Roger Anyon
2003 New Interpretations of Mimbres Public Architecture and Space: Implications for Cultural Change. *American Antiquity* 68(3): 67-92.

Cushing, Frank Hamilton
1920 *Zuni Breadstuff*. Indian Notes and Monographs Vol. VIII. A Series of Publications Relating to the American Aborigines. Museum of the American Indian. Heye Foundation, New York.

Devos, Wim, Marianne Senn-Luder, Christoph Moor and Christopher Salter
2000 Laser Ablation Inductively Coupled Plasma Mass Spectrometry (LA-ICP-MS) for Spatially Resolved Trace Analysis of Early-Medieval Archaeological Iron Finds. *Fresenius Journal of Analytical Chemistry* 366:873-880.

Diehl, Michael W.
1996 The Intensity of Maize Processing and Production in Upland Mogollon Pithouse Villages A.D. 200-1000. *American Antiquity* 61(1):102-115.

Diehl, Michael W.
1997 Changes in Architecture and Land Use Strategies in the American Southwest: Upland Mogollon Pithouse Dwellers, A.D. 200-100. *Journal of Field Archaeology* 24(2):179-194.

Diehl, Michael W., and Stephen A. LeBlanc
2001 *Early Pithouse Villages of the Mimbres Valley and Beyond: The McAnally and Thompson Sites in their Cultural and Ecological Contexts*. Papers of the Peabody Museum of Archaeology and Ethnology. Harvard University, Vol. 83. Cambridge, Massachusetts.

Dockall, John E.
1991 *Chipped Stone Technology at the Nan Ruin, Grant County, New Mexico.* Master's Thesis, Department of Anthropology, Texas A&M University, College Station

Dobres, Marcia-Anne and Christopher R. Hoffman
1999 Introduction: A Context for the Present and Future of Technology Studies. In *The Social Dynamics of Technology: Practice, Politics, and World Views*, edited by Marcia-Anne Dobres and Christopher R. Hoffman pp 1-19. Smithsonian Institution Press, Washington D. C.

Ferguson, T. J., and E. Richard Hart
1985 *A Zuni Atlas*. University of Oklahoma Press, Norman.

Fewkes, Jesse Walter
1989 Archaeology of the Lower Mimbres Valley, New Mexico. In *The Mimbres: Art and Archaeology*. Avanyu Publishing, Albuquerque.

Fitting, James E.
1972 *Chipped Stone from the 1967 Mimbres Area Survey: Parts I and II* . Southwestern New Mexico Research Reports No. 8. Department of Anthropology, Case Western Reserve University, Cleveland.

Gilman, Patricia A.
1990 Social Organization and Classic Mimbres Period Burials in the SW United States. *Journal of Field Archaeology* 17(4):457-469.

Glascock, Michael D.
2002 Obsidian Provenance Research in the Americas. *Accounts of Chemical Research* 35:611-617.

Glascock, Michael D., Geoffrey E. Braswell, and Robert H. Cobean
1998 A Systematic Approach to Obsidian Source Characterization. In *Archaeological Obsidian Studies: Method and Theory,* edited by S. M. Shackley pp. 15-67. Plenum Press, New York.

Glascock, Michael D., Raymond Kunselman and Daniel Wolfman
1999 Intrasource Chemical Differentiation of Obsidian in the Jemez Mountains and Taos Plateau, New Mexico. *Journal of Archaeological Science* 26:861-868.

Gould, Richard A.
1968 Living Archaeology: The Ngatatjara of Western Australia. *Southwestern Journal of Anthropology* 24:101-112.

Gould, Richard A.
1977 Ethnoarchaeology; or, Where do Models come from? In *Stone Tools as Cultural Markers,* edited by R. V. S. Wright pp. 162-168. Australian Institute of Aboriginal Studies, Canberra.

Gould, Richard A.
1978 The Anthropology of Human Residues. *American Anthropologist* 80:815-835

Gould, Richard A.
1980 *Living Archaeology*. Cambridge University Press, Cambridge.

Gould, Richard A., Dorothy A. Koster, and Ann H. L. Sontz
1971 The Lithic Assemblage of the Western Desert Aborigines of Australia. *American Antiquity* 36:149-169.

Greenfield, Stanley and Michael Foulkes
1999 Introduction. In, *Inductively Coupled Plasma Mass Spectrometry and its Application*, edited by S. J. Hill pp. 1-34. Sheffield Academic Press, England.

Gratuze, B.
1999 Obsidian Characterization by Laser Ablation ICP-MS and its Application to Prehistoric Trade in the Mediterranean and the Near East: Sources and Distribution of Obsidian within the Aegean and Anatolia. *Journal of Archaeological Science* 26:869-881.

Gratuze, B. M. Blet-Lemarquand, J.-N. Barrandon
2001 Mass Spectrometry with Laser Sampling: A New Tool to Characterize Archaeological Material. *Journal of Radioanalytical and Nuclear Chemistry* 247(3):645-656.

Haury, Emil W.
1936 *The Mogollon Culture of Southwestern New Mexico*. Medallion Papers No. 20, Gila Pueblo.

Haury, Emil W.
1945 *The Excavation of Los Muertos and Neighboring Ruin in the Salt River Valley, Southern Arizona*. Papers of the Peabody Museum of American Archaeology and Ethnology. Harvard University, Vol. XXIV—No.1. Cambridge, Massachusetts.

Hayden, B.
1977 Stone Tool Functions in the Western Desert. In *Stone Tools as Cultural Markers*, edited by R. V. S. Wright pp. 178-188. Australian Institute of Aboriginal Studies, Canberra.

Hayden, B.
1979 *Paleolithic Reflections: Lithic Technology of the Australian Western Desert.* Australian Institute of Aboriginal Studies, Canberra.

Hayden, David J
1999 Obsidian Sourcing. In *Archaeology of the Mogollon Highlands: Settlement Systems and Adaptation*. Volume 3, pp:199-204. Analysis of Chipped and Ground Stone Artifacts. Edited by Yvonne R. Oakes and Dorothy A. Zamora. Museum of New Mexico, Office of Archaeological Studies, Archaeology Notes 232, Santa Fe.

Hegmon, Michelle
2002 Recent Issues in the Archaeology of the Mimbres Region of the North American Southwest. *Journal of Archaeological Research* 10(4):307-357.

Hegmon, Michelle, Margaret C. Nelson, Roger Anyon, Darrell Creel, Steven A. Leblanc, and Harry J. Shafer
1999 Scale and Time-Space Systematics in the Post-A.D. 1100 Mimbres Region of the American Southwest. *Kiva* 65(2):143-166.

Kamp, Kathryn
1998 *Life in the Pueblo: Understanding the Past through Archaeology*. Waveland Press, Inc. Prospect Heights, Illinois.

LeBlanc, Steven A.
1975 *Mimbres Archaeological Center: Preliminary Report of the First Season of Excavation, 1974*. The Institute of Archaeology. The University of California, Los Angeles.

LeBlanc, Steven A.
1976 Mimbres Archaeological Center: Preliminary Report of the Second Season of Excavation 1975. *Journal of New World Archaeology* 1(6):1-23.

LeBlanc, Steven A.
1977 The 1976 Field Season of the Mimbres Foundation in Southwestern New Mexico. *Journal of New World Archaeology* 2(2):1-24.

LeBlanc, Steven A.
1983 *The Mimbres People: Ancient Pueblo Potters of the American Southwest*. Thames and Hudson, London.

LeBlanc, Steven A.
1989 Cultural Dynamics in the Southern Mogollon Area. In *Dynamics of Southwestern Prehistory,* ed. by Linda S. Cordell and George J. Gumerman, pp. 179-208. Smithsonian Institution Press, Washington D.C.

Leskon, Stephen H.
1988 The Mangas Phase in Mimbres Archaeology. *The Kiva* 53:129-145.

Lekson, Stephen H.
1990 *Mimbres Archaeology of the Upper Gila, New Mexico*. Anthropological Papers No. 53, University of Arizona Press, Tucson

Lekson, Stephen H.
1992 *Archaeological Overview of Southwestern New Mexico (Final Draft)*. Report prepared for New Mexico State Historical Preservation Division, Project no. 35-88-30120.004. Submitted by Human Systems Research, Inc. Las Cruces, New Mexico

Lightfoot, Kent G. and Gary M. Feinman
1982 Social Differentiation and Leadership in Early Pithouse Villages in the Mogollon Region of the American Southwest. *American Antiquity* 47(1):64-86.

Luedtke, B. E.
1984 Lithic Material Demand and Quarry Production. In *Prehistoric Quarries and Lithic Production*, edited by Jonathon E Ericson and Barbara A. Purdy pp. 65-76. Cambridge University Press, Cambdridge.

Malinowski, Bronislaw
1934 Stone Implements of Eastern New Guinea. In *Essays Presented to C. G. Seligman*, edited by E. E. Evans-Pritchard pp. 189-196. London.

Mallory-Greenough, Leanne M., John D. Greenough, and J. Victor Owen
1998 New Data for Old Pots: Trace Element Characterization of Ancient Egyptian Pottery Using LA-ICP-MS. *Journal of Archaeological Science* 25:85-97.

McBryde, Isabel
1978 Wil-im-ee moor-ring: or, Where do Axes come from? *Mankind* 11:354-382.

McBryde, Isabel
1979 Petrology and Prehistory: Lithic Evidence for Exploitation of Stone Resources and Exchange Systems in Australia. In *Stone Axe Studies*, edited by T. H. McK. Clough ad W. A. Cummins pp. 113-126. Council for British Archaeology Research Report 23. Council For British Archaeology, London.

McBryde, Isabel and G. Harrison
1981 Value Goode or Valuable Stone? Consideration of the Distribution of Greenstone Artefacts in South-Eastern Australia. In *Archaeological Studies of Pacific Stone Resources*, edited by F. Leach and J. Davidson pp. 183-208. British Archaeological Reports International Series S104. British Archaeological Reports, Oxford.

McBryde, Isabel and A. L. Watchman
1976 The Distribution of Greenstone Axes in Southeastern Australia: A Preliminary Report. *Mankind* 10:163-174.

McGregor, John C.
1941 *Winona and Ridge Ruin: Part I*. Museum of Northern Arizona Bulletin 18. Northern Arizona Society of Science and Art. Flagstaff, Arizona.

Moiola, Lloyd A.
1999 Chipped Stone Reduction: Material Selection. In *Archaeology of the Mogollon Highlands: Settlement Systems and Adaptation*. Volume 3, pp: 83-128. Analysis of Chipped and Ground Stone Artifacts. Edited by Yvonne R. Oakes and Dorothy A. Zamora. Museum of New Mexico, Office of Archaeological Studies, Archaeology Notes 232, Santa Fe.

Neff, Hector
2003 Analysis of Mesoamerican Plumbate Pottery Surfaces by Laser Ablation-Inductively Coupled Plasma-Mass Spectrometry (LA-ICP-MS). *Journal of Archaeological Science* 30:21-35.

Nelson, Ben and Steven LeBlanc
1986 *Short Term Sedentism in the American Southwest: The Mimbres Valley Salado.* Maxwell Museum of Anthropology and the University of New Mexico Press, Albuquerque, New Mexico.

Nelson, Margaret C.
1984 "Food Selection at Galaz: Inferences from Chipped Stone Analysis" in *The Galaz Ruin: A Prehistoric Mimbres Village in Southwestern New Mexico*. By Roger Anyon and Steven LeBlanc. Maxwell Museum of Anthropology and the University of New Mexico Press, Albuquerque, New Mexico.

Nelson, Margaret C.
1986 "Chipped Stone Analysis: Food Selection and Hunting Behavior" in *Short Term Sedentism in the American Southwest: The Mimbres Valley Salado*. By Ben Nelson and Steven LeBlanc. Maxwell Museum of Anthropology and the University of New Mexico Press, Albuquerque, New Mexico.

Nelson, Margaret C.
1993 Changing Occupational Pattern Among Prehistoric Horticulturalists in Southwestern New Mexico. *Journal of Field Archaeology* 20(1):43-57.

Nelson, Margaret C.
1999 *Mimbres During the Twelfth Century: Abandonment, Continuity, and Reorganization*. The University of Arizona Press, Tucson.

O'Connor, Gavin and Hywel Evans
1999 Fundamental Aspects of ICP-MS. In, *Inductively Coupled Plasma Mass Spectrometry and its Application*, edited by S. J. Hill pp. 119-144. Sheffield Academic Press, England

Peterson, Jane, Douglas R. Mitchell, and M. Steven Shackley
1997 The Social and Economic Contexts of Lithic Procurement: Obsidian from Classic-Period Hohokam Sites. *American Antiquity* 62(3): 231-259.

Pye, Jeremy W.
2004 *Direct Procurement or Trade? Sourcing Florida Mountain (LA18839) Obsidian*. Paper Presented at the 13th Mogollon Archaeology Conference.

Pyne, Lydia V.
2004 *Mimbres Settlement Patterns and Geoecology: A Case Study of Gavilan Canyon*. Master's Thesis, Department of Anthropology, The University of Texas at Austin, Austin.

Reed, Erik K.
1942 Implications of the Mogollon Concept. *American Antiquity* 8(1): 27-32

Roberts, Frank H. H. Jr.
1937 Archaeology in the Southwest. *American Antiquity* 3(1): 3-33

Rinaldo, John
1941 Conjectures on the Independent Development of the Mogollon Culture. *American Antiquity* 7(1): 5-19.

Salisbury, R. F.
1962 *From Stone to Steel*. London.

Schlanger, Nathan
1994 Mindful Technology: Unleashing the *Chaîne Opératoire* for an Archaeology of the Mind. In *The Ancient Mind: Elements of Cognitive Archaeology*, edited by Colin Renfrew and Ezra B. W. Zubrow pp. 143-151. Cambridge University Press, Cambridge.

Shackley, M. Steven
1988 Sources of Archaeological Obsidian in the Southwest: an Archaeological, Petrological, and Geochemical study. *American Antiquity* 53(4): 752-772

Shackley, M. Steven
1995 Sources of Archaeological Obsidian in the Greater American Southwest: an Update and Quantitative Analysis. *American Antiquity* 60(3): 531-551.

Shackley, M. Steven
1998 Current Issues and Future Directions in Archaeological Volcanic Glass Studies: an Introduction. In *Archaeological Obsidian Studies: Method and Theory*, edited by S. M. Shackley pp. 1-14. Plenum Press, New York.

Shackley, M. Steven
1998a Intrasource Chemical Variability and Secondary Depositional Processes: Lessons from the American Southwest. In *Archaeological Obsidian Studies: Method and Theory*, edited by S. M. Shackley pp. 83-102. Plenum Press, New York.

Shackley, M. Steven
1999a An Energy Dispersive X-Ray Fluorescence (EDXRF) Analysis of Obsidian Artifacts from 19 Prehistoric Sites in Catron County, New Mexico. In *Archaeology of the Mogollon Highlands: Settlement Systems and Adaptation*. Volume 3, pp: 287-291. Analysis of Chipped and Ground Stone Artifacts. Edited by Yvonne R. Oakes and Dorothy A. Zamora. Museum of New Mexico, Office of Archaeological Studies, Archaeology Notes 232, Santa Fe.

Shackley, M. Steven
1999b An Energy Dispersive X-Ray Fluorescence (EDXRF) Analysis of Obsidian Artifacts from 11 Prehistoric Sites in Catron County, New Mexico. In *Archaeology of the Mogollon Highlands: Settlement Systems and Adaptation*. Volume 3, pp:293-298. Analysis of Chipped and Ground Stone Artifacts. Edited by Yvonne R. Oakes and Dorothy A. Zamora. Museum of New Mexico, Office of Archaeological Studies, Archaeology Notes 232, Santa Fe.

Shackley, M. Steven
1999c An Energy Dispersive X-Ray Fluorescence (EDXRF) Analysis of Obsidian Artifacts from Four Prehistoric Sites in Catron County, New Mexico. In *Archaeology of the Mogollon Highlands: Settlement Systems and Adaptation*. Volume 3, pp:299. Analysis of Chipped and Ground Stone Artifacts. Edited by Yvonne R. Oakes and Dorothy A. Zamora. Museum of New Mexico, Office of Archaeological Studies, Archaeology Notes 232, Santa Fe.

Shackley, M. Steven
2002 *Source Provenance of Archaeological Obsidian from Mimbres Mogollon Sites in the Cedar Mountains, Southwest New Mexico.* Report prepared for Thomas Holcomb, Bureau of Land Management, Las Cruces, New Mexico.

Shackley, M. Steven
2004 Berkeley Archaeological XRF Lab: Analysis of Geoarchaeological Materials. *Sources of Archaeological Obsidian in the Greater American Southwest*, Electronic Document, http://www.swxrflab.net/swobsrcs.htm , accessed June 20, 2004.

Shackley, M. Steven
2004a *Source Provenance of Obsidian Artifacts from the Florida Mountiains Site (LA 18839) Southern New Mexico*. Report prepared for Jeremy Pye, Department of Anthropology, University of Oklahoma, Norman. Berkeley Archaeological XRF Lab.

Shafer, Harry J.
1990 Archaeology at the NAN Ruin: 1984 Interim Report. *The Artifact* 28(4): 5-27.

Shafer, Harry J.
1991a Archaeology at the NAN Ruin (LA15049): 1985 Interim Report. *The Artifact* 29(1):1-29.

Shafer, Harry J.
1991b Archaeology at the NAN Ruin: 1986 Interim Report. *The Artifact* 29(2):1-42.

Shafer, Harry J.
1991c Archaeology at the NAN Ruin: The 1987 Season. *The Artifact* 29(3):1-43.

Shafer, Harry J.
1991d Archaeology at the NAN Ruin: The 1989 Season. *The Artifact* 29(4):1-43.

Shafer, Harry J.
2003 *Mimbres Archaeology at the NAN Ruin*. University of New Mexico Press, Albuquerque.

Shafer, Harry J. and Anna J. Taylor
1986 Mimbres Mogollon Architectural Dynamics and Ceramic Style Change. *Journal of Field Archaeology* 13(1):43-68.

Shafer, Harry and Robbie Brewington
1995 Microstylistic Changes in Mimbres Black-on-white Pottery: Examples form the NAN Ruin, Grant County, New Mexico. *The Kiva* 61:5-29

Speakman, Robert J., Hector Neff, Michael Glascock and Barry J Higgens
2002 Characterization of Archaeological Materials by Laser Ablation-Inductively Coupled Plasma-Mass Spectrometry. In *Archaeological Chemistry: Materials, Methods, and Meaning*, edited by K. A. Jakes pp. 48-63. American Chemical Society Symposium Series No. 831. Oxford University Press.

Stevenson, Matilda Coxe
1904 *The Zuni Indians: Their Mythology, Esoteric Fraternities, and Ceremonies*. Twenty-third Annual Report of the Bureau of American Ethnology to the Secretary of the Smithsonian Institution, 1901-1902. Washington Government Printing Office.

Stevenson, Christopher M. and Michael O. McCurry
1990 Chemical Characterization and Hydration Rate Development for New Mexican Obsidian Sources. *Geoarchaeology* 5(2):149-170.

Stokes, Robert J. and Barbara J. Roth
1999 Mobility, Sedentism, and Settlement Patterns in Transition: The Late Pithouse Period in the Sapillo Valley, New Mexico. *Journal of Field Archaeology* 26(4):423-434.

Stuart, David E., and Rory P. Gauthier
1981 *Prehistoric New Mexico: Background for Survey*. University of New Mexico Press, Alburquerque, New Mexico.

Talayesva, Don
1944 *Sun Chief: The Autobiography of a Hopi Indian.* Edited by Leo. W. Simmons. Yale University Press, New Haven.

Taylor, Howard E.
2001 *Inductively Coupled Plasma Mass Spectrometry: Practices and Techniques*. Academic Press, San Diego.

Taylor, Walter W.
1967 *A Study of Archaeology*. Southern Illinois University Press, Carbondale.

Titiev, Mischa
1944 *Old Oraibi: A Study of the Hopi Indians of Third Mesa*. Papers of the Peabody Museum of American Archaeology and Ethnology, Harvard University, Vol. XXII No. 1. Cambridge, Massachusetts. Published by the Museum.

Titiev, Mischa
1972 *The Hopi Indians of Old Oraibi: Continuity and Change.* The University of Michigan Press, Ann Arbor.

Thomson, Donald
1949 *Economic Structure and the Ceremonial Exchange Cycle in Arnhem Land.* Macmillan Press, Melbourne.

Torrence, Robin
1986 *Production and Exchange of Stone Tools: Prehistoric Obsidian in the Aegean*. Cambridge University Press, Cambridge.

Van Der Leeuw, S. E.
1994 Cognitive Aspects of 'Technique.' In *The Ancient Mind: Elements of Cognitive Archaeology*, edited by Colin Renfrew and Ezra B. W. Zubrow pp. 135-142. Cambridge University Press, Cambridge.

University of New Mexico
2004 New Mexico Resource Geographic Information System Program, *New Mexico Vegetation Map: Raster Format Image and Corresponding Metadata*. Electronic Document, http://rgis.unm.edu ,accessed June 20, 2004.

Vogt, Evon Z. and Ethel M. Albert
1966 *People of Rimrock; A Study of Values in Five Cultures.* Harvard University Press, Cambridge.

Ward, Albert E. et. al.
1987 *Archaeological Investigations at Los Esteros Reservoir, Northeastern New Mexico.* Center for Anthropological Studies, Albuquerque, New Mexico.

Weigand, Phil C. and Garman Harbottle
1993 The Role of Turquoise in the Ancient American Trade Structure. In *Them American Southwest and Meson America: Systems of Prehistoric Exchange*, edited by Jonathon E. Ericson and Timothy G. Baugh pp. 159-178. Plenum Press, New York.

Weigand, Phil C., Garman Harbottle, and Edward V. Sayre
1977 Turquoise Sources and Source Analysis: Mesoamerican and the Southwestern U.S.A. In *Exchange Systems in Prehistory*, edited by Timothy K. Earle and Jonathon E. Ericson pp. 15-34. Academic Press, New York.

Wheat, Joe Ben.
1955 *Mogollon Culture Prior to A.D. 1000*. Memoirs of the Society for American Archaeology, No. Supplement to American Antiquity, Vol. XX, No. 4, Part 2). The University of Utah Press, Salt Lake City, Utah.

Appendix A: Descriptive attributes of typable points

The preceding work with the Old Town projectile point assemblage focused on the formation of a morphological typology for the points recovered from the site, and as part of this initial analysis, various metric attributes were recorded. Figure 26 shows where on the points these measurements were taken. The measurements recorded were maximum length, maximum width, maximum thickness, blade length (BLL), haft length (HL), blade width (BLW), neck width (NW), base width (BW), and the shoulder to basal corner (SBC) width. The measurements for the different projectile points can be found in the appendices.

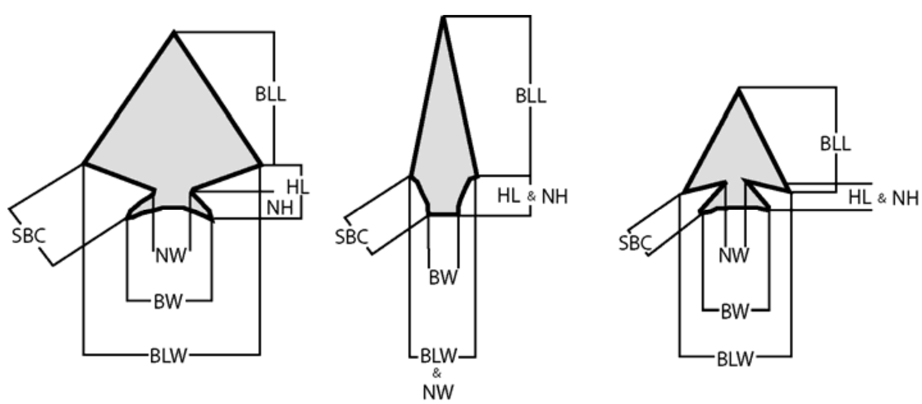


Figure 26: Measurements recorded for different points excavated from Old Town (Taken from Andrefsky 1992)

APPENDIX A: Descriptive attributes of typable points

Specimen #	Material	Length	Width	Thickness	Shape	Basal Edge Shape	Notch Type	Blade Length	Haft Length	Blade Width	Neck Width	Base Width	SBC	Provenience
A1-1	chert	28.6mm	14.3mm	8.1mm	triangular	straight / convex	side	21.3mm	8.9mm	13.4mm	12.3mm	14.3mm	3.7mm	Area: C Surface Lot 7216
A1-2	chert	18.9mm	9.9mm	2.8mm	triangular	concave	1 side notch	18.9mm	7.8mm	9.9mm	7.1mm	9.9mm	N/A	Area:A Unit:1C Rm.:A7 Lot:1563
A1-3	chert	19.8mm	17.4mm	4.6mm	triangular	straight / slightly concave	serrated lateral edge	19.8mm	6.7mm	17.4mm	15.1mm	17.4mm	N/A	Area:A Surface Lot:1656
A1-4	chert	15.9mm	13.3mm	2.7mm	triangular	straight / slightly convex	N/A	15.4mm	5.1mm	13.3mm	10.7mm	13.3mm	N/A	Area:A Unit:1C Rm.:A7 Lot 1563
A1-5	chert	14.0mm	10.2mm	2.2mm	triangular	concave	N/A	13.1mm	3.4mm	10.2mm	10.2mm	10.2mm	N/A	Area:C Unit:26 Feature:14 Lot:2704
A1-6	chert	23.1mm	15.1mm	2.9mm	triangular	convex	N/A	18.9mm	5.2mm	15.1mm	15.1mm	13.0mm	N/A	Area:A Unit:1C Rm.:A7 Lot:1532
A1-7	obsidian	14.8mm	7.5mm	3.2mm	triangular	straight	N/A	14.8mm	3.1mm	7.5mm	6.1mm	6.1mm	N/A	Area: C Unit: 14 Lvl: 1 Lot:1736
A2-1	obsidian	14.9mm	8.6mm	2.9mm	triangular	contracting stem	corner	10.4mm	5.4mm	8.6mm	4.2mm	4.2mm	N/A	Area:A Unit:32 Lvl:3 Lot:3853
A2-2	obsidian	fragment	9.2mm	2.1mm	triangular	contracting stem	corner	fragment	4.3mm	9.2mm	4.9mm	3.8mm	1.8mm	Area:A Unit:22 Lot:4884
A2-3	chalcedony	15.5mm	8.8mm	2.4mm	triangular	contracting stem	corner	11.1mm	6.1mm	8.8mm	5.0mm	4.8mm	N/A	Area:A Unit:22 Lvl:1 Lot:4517
A2-4	obsidian	16.8mm	9.7mm	4.2mm	triangular	contracting stem	corner	11.7mm	6.4mm	9.7mm	5.7mm	5.2mm	N/A	Area:A Unit:22 Rm.:A16 Lot:4279
A2-5	chert	fragment	13.4mm	4.0mm	triangular	contracting stem	barbed	21.5mm	fragment	13.4mm	4.2mm	fragment	fragment	Area:A Unit:31F Lvl:4 Lot:3796
A2-6	chert	fragment	12.1mm	2.9mm	triangular	contracting stem	barbed	22.9mm	fragment	12.1mm	4.9mm	fragment	fragment	Area:A Unit:22 Surface Lot:4441
A2-7	obsidian	fragment	fragment	fragment	triangular	contracting stem	barbed	fragment	5.3mm	fragment	6.5mm	6.9mm	fragment	Area:A General Surface Lot:1656
A2-8	rhyolite	fragment	fragment	fragment	fragment	fragment	barbed	fragment	fragment	fragment	4.8mm	fragment	fragment	Area:A Unit:2 Lvl:1 Lot:3477
A2-9	obsidian	fragment	11.0mm	2.8mm	triangular	fragment	barbed	16.9mm	fragment	11.0mm	4.1mm	fragment	fragment	Area:A Unit:32 Lvl:2 Lot:4229
A2-10	obsidian	16.1mm	7.9mm	2.9mm	triangular	straight	corner	12.9mm	4.4mm	7.9mm	5.1mm	5.8mm	3.2mm	Area: A Unit: 22 Lvl: 2 Lot:4192
A3-1	obsidian	12.0mm	9.2mm	1.7mm	triangular	convex	corner	9.8mm	3.8mm	9.2mm	5.6mm	6.5mm	1.8mm	Area:A Unit:32 Lvl:6 Lot:4299
A3-2	obsidian	18.2mm	8.9mm	2.8mm	triangular	straight	side	13.1mm	5.5mm	8.2mm	6.6mm	fragment	1.8mm	Area: A Unit: 2 Surface Lot: 3441
A3-3	obsidian	21.4mm	11.2mm	4.8mm	triangular	convex	side	15.8mm	7.7mm	11.2mm	9.0mm	10.2mm	4.1mm	Area: C Unit: 15 Lvl: 1 Lot: 1745
A3-4	chalcedony	24.8mm	11.8mm	3.7mm	triangular	straight	corner	22.1mm	3.2mm	11.8mm	7.9mm	7.1mm	2.3mm	Area: A Unit: 32 Feat: A40 Burial 14 Lot:3604
A3-5	chert	19.1mm	9.1mm	2.8mm	triangular	straight / slightly convex	corner	16.2mm	3.6mm	9.1mm	5.4mm	7.9mm	2.4mm	Area: A Unit: 31E Lvl: 1 Lot: 3710
A3-6	chert	23.2mm	12.0mm	2.9mm	triangular	straight	corner	19.3mm	5.8mm	12.0mm	6.2mm	8.6mm	4.4mm	Area: A Unit: 1C Rm:A7 Lot: 1517
A3-7	obsidian	fragment	fragment	fragment	triangular	fragment	fragment	fragment	fragment	fragment	fragment	fragment	fragment	Area: A Unit: 1A Rm: A1/5 Lot:13

Appendix A: All measurement are in mm. Specimen numbers also represent point type where M1 = Mimbres Type point number 1, S1 = Swarts Type point number 1, H1 = Hinton Type point number 1, C1 = Cosgrove Type point number 1, A1-1 = A1 Type point number 1, A2-1 = A2 Type point number 1, A3-1 = A3 Type point number 1, A4-1 = A4 Type point number 1, A5-1 = A5 Type point number 1, SP1 = San Pedro Type point number 1, CH1 = Chiricahua Type point number1, D1-1 = D1 Type point number 1, D2-1 = D2 Type point number 1, D4-1 = D4 Type point number 1, and D5-1 = D5 Type point number 1.

APPENDIX A: Descriptive attributes of typable points

Specimen #	Material	Length	Width	Thickness	Shape	Basal Edge Shape	Notch Type	Blade Length	Haft Length	Blade Width	Neck Width	Base Width	SBC	Provenience
A3-8	obsidian	fragment	fragment	fragment	triangular	fragment	fragment	fragment	fragment	fragment	fragment	fragment	fragment	Area: A Unit: 22 Rm:A16 Lot:3035
A3-9	obsidian	fragment	8.1mm	2.4mm	triangular	fragment	corner	10.8mm	fragment	8.1mm	3.9mm	fragment	fragment	Area: A Unit: 1C Rm:A Lot:1647
A4-1	obsidian	fragment	8.4mm	3.8mm	fragment	convex	side	fragment	7.3mm	8.2mm	5.8mm	8.4mm	5.1mm	Area:A Unit:22 Lot:4696
A4-2	obsidian	fragment	fragment	fragment	fragment	straight	side	fragment	5.4mm	fragment	5.9mm	8.1mm	fragment	Area:A Unit:32 Feat.:A40 Burial:14 Lot:3624
A4-3	obsidian	23.8mm	10.1mm	3.4mm	triangular	straight	side / serrated	20.0mm	4.2mm	10.1mm	7.1mm	8.2mm	4.0mm	Area:A Unit:1C Rm.:A7 Lot:1523
A4-4	obsidian	fragment	8.9mm	3.9mm	triangular	straight / slightly convex	side / serrated	fragment	5.5mm	8.9mm	7.3mm	8.9mm	3.9mm	Area:A Unit:32 Lvl:5 Lot:3658
A4-5	obsidian	22.7mm	9.3mm	5.9mm	triangular	convex	side / serrated	17.7mm	5.8mm	9.3mm	6.2mm	8.2mm	3.0mm	Area:A General Surface Collection Lot:5103
A4-6	obsidian	23.5mm	8.9mm	4.3mm	triangular	convex	side / serrated	18.9mm	5.1mm	8.9mm	7.1mm	8.1mm	3.6mm	Area:A Unit:1C Rm.:A7 Lot:1537
A4-7	chert	21.1mm	14.8mm	2.9mm	triangular	straight / slightly concave	N/A	21.1mm	8.1mm	14.8mm	10.9mm	14.8mm	N/A	Area:A Unit:1C Rm.:A7 Lot:1563
A5-1	obsidian	23.9mm	11.1mm	3.2mm	triangular	straight / slightly convex	side	20.2mm	5.3mm	10.8mm	7.3mm	11.1mm	2.4mm	Area:A Unit:22 above feature A104 Lot:6001
C1	chert	40.2mm	25.1mm	5.4mm	triangular	concave / eared	corner / basal	36.7mm	9.9mm	25.1mm	10.7mm	16.1mm	5.2mm	Area:A Unit:32 Lvl:5 Lot:4293
C1	chalcedony	15.6mm	9.1mm	3.5mm	triangular	straight / slightly convex	side: 2 on 1 lateral edge	10.1mm	6.3mm	8.3mm	6.9mm	9.1mm	2.7mm	Area:B Unit:24 Surface Lot:2609
C10	obsidian	15.0mm	8.9mm	2.9mm	triangular	straight / slightly convex	side: 2 on 1 lateral edge	9.7mm	6.1mm	6.6mm	4.9mm	8.9mm	2.2mm	Area:A Unit:22 Rm.:A16 Lvl:3 Lot:3099
C1-03	obsidian	16.2	10.3	2.4	triangular	straight	multiple on 1 lateral edge	11.3	4.1	8.3	5.5	10.3	1.7	Lvl 2 annex Lot 6943
C11	obsidian	21.6mm	9.8mm	2.9mm	triangular	concave	side: 2 on 1 lateral edge	17.1mm	5.2mm	8.1mm	6.1mm	9.8mm	1.9mm	Area:A Unit:22 Rm.:A16 Lvl:3 Lot:3099
C12	obsidian	fragment	4.4mm	fragment	triangular	straight / slightly convex	side: 2 on 1 lateral edge	fragment	6.2mm	13.1mm	11.1mm	fragment	3.2mm	Area:A Unit:22 Lot:2921
C13	obsidian	fragment	fragment	fragment	fragment	fragment	side: 4 on 1 lateral edge	fragment	fragment	7.9mm	5.1mm	fragment	fragment	Area:A Unit:1C Rm.:A7 Lot:1561
C14	obsidian	18.8mm	fragment	3.0mm	triangular	straight	side: 2 on 1 lateral edge	13.2mm	6.1mm	8.9mm	6.6mm	fragment	fragment	Area:A Unit:1C Rm.:A7 Lot:1501
C15	chalcedony	23.8mm	8.7mm	3.1mm	triangular	straight / slightly convex	side: 2 on 1 lateral edge	19.2mm	5.2mm	8.7mm	4.9mm	8.1mm	3.4mm	Area:A Unit 1A Rm.: A5 Lot:379
C16	obsidian	22.1mm	10.9mm	2.9mm	triangular	concave	2 on both lateral edges	14.1mm	5.7mm	9.9mm	5.9mm	10.9mm	2.3mm	Area:A Unit:1A Rm.:A1 Lot:13
C17	obsidian	fragment	fragment	fragment	fragment	fragment	side: 4 on 1 lateral edge	fragment	fragment	10.2mm	6.2mm	fragment	fragment	Area:A Unit:1A Rm.:A5 Lot:95
C18	obsidian	fragment	8.8mm	2.6mm	triangular	straight	side: 3 on 1 lateral edge	fragment	4.8mm	7.8mm	5.6mm	8.8mm	2.1mm	Area:A Unit:1A Rm.:A1 Lot:13
C19	obsidian	fragment	12.1mm	fragment	triangular	concave	multiple on 1 lateral edge	fragment	5.3mm	10.1mm	7.8mm	12.1mm	2.3mm	Area:A Unit:2 Lvl:1 Lot:3477
C2	obsidian	fragment	fragment	fragment	fragment	fragment	side: 2 on 1 lateral edge	fragment	fragment	fragment	fragment	fragment	fragment	Area:A Unit:22 Rm.:A16 Lot:3347

Appendix A: All measurement are in mm. Specimen numbers also represent point type where M1 = Mimbres Type point number 1, S1 = Swarts Type point number 1, H1 = Hinton Type point number 1, C1 = Cosgrove Type point number 1, A1-1 = A1 Type point number 1, A2-1 = A2 Type point number 1, A3-1 = A3 Type point number 1, A4-1 = A4 Type point number 1, A5-1 = A5 Type point number 1, SP1 = San Pedro Type point number 1, CH1 = Chiricahua Type point number1, D1-1 = D1 Type point number 1, D2-1 = D2 Type point number 1, D4-1 = D4 Type point number 1, and D5-1 = D5 Type point number 1.

APPENDIX A: Descriptive attributes of typable points

Specimen #	Material	Length	Width	Thickness	Shape	Basal Edge Shape	Notch Type	Blade Length	Haft Length	Blade Width	Neck Width	Base Width	SBC	Provenience
C2	rhyolite	fragment	22.1mm	6.0mm	triangular	concave / eared	corner / basal	fragment	6.7mm	22.1mm	11.3mm	12.1mm	5.1mm	Area:A Unit:22 A71-1 Lot:4960
C20	obsidian	20.3mm	fragment	2.8mm	triangular	straight / slightly convex	side: 2 on 1 lateral edge	16.3mm	5.1mm	8.3mm	fragment	fragment	2.0mm	Area:A Unit:1C Rm.:92 Lot:6679
C2-03	obsidian	fragment	9.5	3.7	triangular	straight / convex	multiple on 1 lateral edge	fragment	3.6	6.8	6	9.5	0.9	Lvl E. Wall Annex Lot 6925
C21	obsidian	fragment	8.6mm	3.5mm	triangular	straight / convex	multiple on 1 lateral edge	fragment	5.8mm	7..4mm	5.1mm	8.6mm	2.8mm	Area:A Unit:32 Lvl:1 Lot:4222
C22	obsidian	14.8mm	8.9mm	3.1mm	triangular	straight / convex	multiple on 1 lateral edge	9.1mm	5.7mm	7.2mm	5.9mm	8.9mm	2.2mm	Area:A Unit: 22 Rm.:A16 Lot:4553
C23	obsidian	26.0mm	9.9mm	3.1mm	triangular	straight / slightly convex	serrated	22.5mm	4.6mm	9.1mm	6.9mm	9.9mm	1.9mm	Area:A Unit:22 Rm.:A16 Lot:3223
C24	chalcedony	fragment	10.1mm	4.1mm	triangular	convex	serrated	fragment	5.3mm	8.9mm	6.8mm	10.1mm	2.6mm	Area:A Unit:1A Rm:A5 Lot:379
C25	chert	fragment	11.8mm	2.8mm	triangular	convex	serrated	fragment	5.8mm	10.0mm	8.1mm	11.8mm	3.1mm	Area:A Unit:1A Rm.:A5 Lot:115
C3	obsidian	16.3mm	8.6mm	3.2mm	triangular	straight / slightly convex	side: 2 on 1 lateral edge	10.9mm	6.1mm	7.8mm	5.2mm	8.6mm	3.9mm	Area:A Unit:1C Rm.:A2 Lot:24
C4	chalcedony	23.4mm	11.2mm	3.9mm	triangular	straight / slightly convex	side: 2 on 1 lateral edge	17.2mm	7.2mm	9.8mm	6.1mm	11.2mm	3.1mm	Area:A Unit:1C Rm.:A9 Lot:6317
C5	obsidian	20.4mm	9.8mm	3.1mm	triangular	straight / slightly convex	side: 3 on 1 lateral edge	15.8mm	5.1mm	8.8mm	6.3mm	9.8mm	1.2mm	Area:A Unit:32 Lot:4321
C6	obsidian	fragment	fragment	fragment	fragment	fragment	side: 2 on 1 lateral edge	fragment	fragment	fragment	fragment	fragment	fragment	Area:A Unit:31F Lvl:4 Lot:3794
C7	obsidian	fragment	fragment	fragment	fragment	fragment	multiple notches	fragment	fragment	fragment	fragment	fragment	fragment	Area:A Unit:31F Lvl:4 Lot:3794
C8	obsidian	19.1mm	10.2mm	2.8mm	triangular	convex	side: 2 on 1 lateral edge	13.5mm	7.1mm	9.0mm	7.6mm	10.2mm	2.1mm	Area:A Unit :31 Lvl:1 Lot:3619
C9	obsidian	fragment	fragment	fragment	fragment	fragment	side: 3 on 1 lateral edge	fragment	fragment	fragment	fragment	fragment	fragment	Area:A Unit:22 Rm.:A16 Lvl:1 Lot:3200
CH1	chert	40.2mm	25.1mm	5.4mm	triangular	concave / eared	corner / basal	36.7mm	9.9mm	25.1mm	10.7mm	16.1mm	5.2mm	Area:A Unit:32 Lvl:5 Lot:4293
CH2	rhyolite		22.1mm	6.0mm	triangular	concave / eared	corner / basal		6.7mm	22.1mm	11.3mm	12.1mm	5.1mm	Area:A Unit:22 Feat.:A71-1 Lot:4960
D1-1	chert	fragment	27.7mm	7.9mm	triangular	convex	side / corner	fragment	12.8mm	27.7mm	12.4mm	16.1mm	11.6mm	Area:A Unit:1C Rm.:A7 Lot:1563
D1-2	chalcedony	30.7mm	20.0mm	4.6mm	triangular	straight	corner	25.3mm	7.4mm	20.0mm	14.5mm	fragment	6.2mm	Area:C Unit:16 Lot:1777
D1-3	chalcedony	fragment	19.5mm	5.1mm	triangular	straight	corner	fragment	7.5mm	19.5mm	13.9mm	16.9mm	4.8mm	Area:C General Surface Collection Lot:2051
D1-4	chert	31.0mm	18.5mm	4.0mm	triangular	straight	corner	21.9mm	6.2mm	18.5mm	11.0mm	13.8mm	4.6mm	Area:A General Surface Collection Lot:29
D1-5	chert	43.2mm	20.4mm	4.1mm	triangular	straight / slightly convex	corner	37.7mm	7.0mm	20.4mm	11.3mm	fragment	4.8mm	Area:A Unit:1C Rm.:A2 Lot:4019
D1-6	chert	fragment	fragment	4.5mm	triangular	straight / slightly convex	corner	fragment	6.8mm	fragment	10.2mm	fragment	4.3mm	Area: A Unit: 22 Rm: A16 Lot: 3283
D1-7	chert	25.8mm	fragment	5.8mm	triangular	fragment	corner	22.8mm	5.9mm	fragment	8.5mm	fragment	6.1mm	Area: A Unit: 22 Rm: A16 Lot: 3223
D1-8	chert	fragment	23.6mm	10.1mm	triangular	straight / convex	side / stemmed	fragment	10.8mm	23.6mm	13.2mm	fragment	fragment	Area: A Unit: 1c Rm: A3 Lot 7102
D2-1	shiest	47.0mm	24.1mm	6.4mm	triangular	convex	side	37.2mm	11.1mm	24.1mm	18.9mm	23.7mm	4.2mm	Area:D Unit:1 Lvl:2 Lot:60

Appendix A: All measurement are in mm. Specimen numbers also represent point type where M1 = Mimbres Type point number 1, S1 = Swarts Type point number 1, H1 = Hinton Type point number 1, C1 = Cosgrove Type point number 1, A1-1 = A1 Type point number 1, A2-1 = A2 Type point number 1, A3-1 = A3 Type point number 1, A4-1 = A4 Type point number 1, A5-1 = A5 Type point number 1, SP1 = San Pedro Type point number 1, CH1 = Chiricahua Type point number1, D1-1 = D1 Type point number 1, D2-1 = D2 Type point number 1, D4-1 = D4 Type point number 1, and D5-1 = D5 Type point number 1.

APPENDIX A: Descriptive attributes of typable points

Specimen #	Material	Length	Width	Thickness	Shape	Basal Edge Shape	Notch Type	Blade Length	Haft Length	Blade Width	Neck Width	Base Width	SBC	Provenience
D4-1	chalcedony	30.99mm	20.0mm	6.3mm	triangular	convex	corner/barbed serrated	28.7mm	7.3mm	20.0mm	7.8mm	8.6mm	5.9mm	Area:A Unit:1A Lot:13
D5-1	rhyolite	39.9mm	26.5mm	5.3mm	triangular	convex	corner/barbed	36.3mm	7.9mm	11.4mm	26.5mm	13.8mm	6.1mm	Area:B Unit:21 Rm.:B9 Feat.:B9-15 Lot:2648
D5-2	chert	42.8mm	23.8mm	3.8mm	triangular	straight	corner/barbed	38.8mm	7.2mm	23.8mm	10.1mm	13.8mm	6.2mm	Area:A Unit:7 Lvl:3 Lot:1538
D5-3	chert	36.3mm	19.4mm	5.4mm	triangular	convex	corner	30.9mm	7.9mm	19.3mm	10.2mm	11.2mm	4.2mm	Area: A Unit: 22 Rm: A16 Lot 3264
D5-4	obsidian	24.2mm	16.5mm	4.1mm	triangular	convex	corner	18.6mm	7.4mm	16.5mm	8.9mm	10.9mm	4.2mm	Surface Collection Bull Dozer Trench: vicinity of Area: A
H1	obsidian	27.9mm	11.0mm	3.9mm	triangular	concave/notched	side and basal	20.5mm	8.6mm	7.3mm	5.2mm	11.0mm	3.2mm	Area:A Unit:1C Feat/Rm.:A7-26 Lot:1637
H10	chert	fragment	fragment	fragment	fragment	concave/notched	side and basal	fragment	9.8mm	fragment	fragment	13.1mm	1.6mm	Area:C Unit:26 Feature:15 Lot:2776
H11	chalcedony	20.2mm	15.0mm	3.8mm	triangular	concave/notched	side and basal	11.7mm	9.9mm	9.4mm	8.5mm	15.0mm	2.4mm	Area:A Unit:1C Rm.:7 Lot:858
H12	chert	fragment	fragment	fragment	fragment	concave/notched	side and basal	fragment	9.9mm	fragment	7.2mm	fragment	5.3mm	Area:C Surface Transit:160 Lot:71
H13	obsidian	21.8mm	14.4mm	3.8mm	triangular	concave	side and basal	15.2mm	8.2mm	11.1mm	7.8mm	14.4mm	2.4mm	Area:C Unit:26 Lot:2791
H14	chalcedony	fragment	fragment	fragment	fragment	concave	basal (?) reworked	fragment	fragment	fragment	fragment	fragment	fragment	Area:C Unit:26 Lot:2747
H15	chalcedony	20.3mm	14.1mm	3.1mm	triangular	concave	basal (?) reworked	10.9mm	9.9mm	6.7mm	6.5mm	14.1mm	>1.0mm	Area:A Unit:1C Rm.:A7 Lot:1517
H16	chalcedony	22.7mm	13.2mm	2.0mm	triangular	concave	basal (?) reworked	13.8mm	8.9mm	9.0mm	9.0mm	13.2mm	>1.0mm	Area:C Unit:16 Lot:1777
H17	obsidian	22.7mm	10.2mm	4.2mm	triangular	concave	side	18.0mm	5.1mm	8.7mm	7.1mm	10.2mm	2.5mm	Area:C Unit:16 Lot:3050
H18	chert	fragment	14.2mm	4.3mm	triangular	concave / notched	side / basal	fragment	11.0mm	8.6mm	8.6mm	14.2mm	N/A	Area: A Unit: 1c Rm: 110 Lot 7072
H19	chert	24.9mm	12.6mm	2.2mm	triangular	concave / notched	side / basal	15.3mm	9.0mm	7.1mm	5.7mm	12.6mm	0.9mm	Area: A Unit: 1c Rm: 110 Lot 6836
H2	obsidian	30.1mm	9.1mm	3.2mm	triangular	concave/notched	side and basal	22.7mm	7.9mm	8.1mm	5.1mm	9.1mm	2.9mm	Area:A Unit:7 Feature A10-10 Lot:1581
H20	chalcedony	25.7mm	13.2mm	2.7mm	triangular	concave / notched	side / basal	16.6mm	8.3mm	8.0mm	6.7mm	13.2mm	1.9mm	Area: A Unit: 1c Rm: 110 Lot 7072
H21	chert	fragment	15.6mm	4.4mm	triangular	concave / notched	N/A	fragment	8.8mm	13.3mm	13.2mm	15.6mm	N/A	Area: A Unit: 1c Rm: 110 Lot 7031
H3	obsidian	30.8mm	8.8mm	4.1mm	triangular	concave/notched	side and basal	23.3mm	7.7mm	7.5mm	5.3mm	8.8mm	3.4mm	Area:A Unit:1C Rm.:A6 Lot:829
H4	chert	20.5mm	10.7mm	2.1mm	triangular	concave/notched	side and basal	11.2mm	10.8mm	6.7mm	4.2mm	10.7mm	1.4mm	Area:C Unit:14 Rm.:C2 Lot:1923
H5	obsidian	20.1mm	10.9mm	2.8mm	triangular	concave/notched	side and basal	12.1mm	8.3mm	7.9mm	6.2mm	10.9mm	1.9mm	Area:C Unit:14 Rm.:C1 Lot:1946
H6	chalcedony	16.5mm	11.1mm	1.8mm	triangular	concave/notched	side and basal	8.8mm	8.9mm	6.8mm	5.1mm	11.1mm	1.5mm	Area:C Unit:14 Rm.:C1 Lot:1946
H7	chert	19.1mm	10.8mm	2.9mm	triangular	concave/notched	side and basal	10.8mm	10.9mm	8.3mm	6.7mm	10.8mm	2.1mm	Area:C Unit:26 Lot:2700

Appendix A: All measurement are in mm. Specimen numbers also represent point type where M1 = Mimbres Type point number 1, S1 = Swarts Type point number 1, H1 = Hinton Type point number 1, C1 = Cosgrove Type point number 1, A1-1 = A1 Type point number 1, A2-1 = A2 Type point number 1, A3-1 = A3 Type point number 1, A4-1 = A4 Type point number 1, A5-1 = A5 Type point number 1, SP1 = San Pedro Type point number 1, CH1 = Chiricahua Type point number1, D1-1 = D1 Type point number 1, D2-1 = D2 Type point number 1, D4-1 = D4 Type point number 1, and D5-1 = D5 Type point number 1.

APPENDIX A: Descriptive attributes of typable points

Specimen #	Material	Length	Width	Thickness	Shape	Basal Edge Shape	Notch Type	Blade Length	Haft Length	Blade Width	Neck Width	Base Width	SBC	Provenience
H8	chert	fragment	fragment	fragment	fragment	concave/notched	side and basal	fragment	fragment	fragment	fragment	11.8mm	fragment	Area:A Unit:1C Rm.:A7 Lot:1561
H9	chert	fragment	fragment	fragment	fragment	concave/notched	side and basal	fragment	10.1mm	fragment	fragment	10.1mm	1.8mm	Area:A Unit:22 Rm.:A71 Lvl:2 Lot:5052
M1	obsidian	13.9mm	9.0mm	1.8mm	triangular	rounded / convex	corner	11.9mm	3.8mm	9.0mm	5.1mm	7.4mm	>1.0mm	Area:B Unit:21 Rm:B11 Lot:2413
M10	obsidian	15.4mm	9.0mm	3.6mm	triangular	convex	corner	12.4mm	3.9mm	9.0mm	5.8mm	7.9mm	2.8mm	Area:A Unit:22 Rm:A22 Lvl:1 Lot:3195
M11	chalcedony	52.1mm	14.3mm	3.7mm	triangular	convex	corner	49.8mm	3.8mm	14.3mm	9.8mm	13.4mm	1.9mm	Area:C Lot:3936
M12	rhyolite	21.8mm	13.7mm	3.3mm	triangular	straight	corner	18.9mm	5.0mm	13.7mm	7.5mm	fragment	fragment	Area:A Unit:31F Lvl:4 Lot:3795
M13	obsidian	fragment	11.7mm	fragment	triangular	convex	corner	fragment	5.1mm	11.7mm	5.6mm	fragment	fragment	Area:A Unit:32 Lvl:4 Lot:3539
M14	chert	15.2mm	10.8mm	2.9mm	triangular	convex	corner	12.9mm	3.9mm	10.8mm	8.1mm	9.1mm	1.9mm	Area:B Unit:4 Lvl:3 Lot:930
M15	obsidian	11.1mm	10.7mm	2.1mm	triangular	convex	corner	10.1mm	3.4mm	10.7mm	6.0mm	7.8mm	2.1mm	Area:A Unit:22 Rm:A71 Lot:6106
M16	rhyolite	25.2mm	10.8mm	3.4mm	triangular	straight / slightly convex	corner	21.4mm	4.9mm	10.8mm	5.7mm	10.4mm	1.9mm	Area:A Surface Lot:6062
M17	obsidian	fragment	fragment	3.1mm	triangular	straight / slightly convex	corner	fragment	4.2mm	9.2mm	5.0mm	fragment	2.7mm	Area:A Surface Lot:2896
M18	obsidian	19.1mm	8.6mm	2.9mm	triangular	convex	corner	13.8mm	3.7mm	8.6mm	4.8mm	fragment	2.3mm	Area: B Unit: 4 Lvl.:2 Lot: 330
M19	obsidian	24.2mm	fragment	3.9mm	triangular	straight	corner	fragment	4.1mm	fragment	6.7mm	fragment	fragment	Area:A Unit: 1c Rm: 110 Lot 6885
M2	obsidian	15.3mm	8.9mm	2.8mm	triangular	convex	corner	11.8mm	5.1mm	8.9mm	6.2mm	8.3mm	3.0mm	Area:A Unit:32 Lvl:7 Lot 3926
M20	obsidian	23.8mm	11.9mm	2.8mm	triangular	convex	corner	21.1mm	5.7mm	11.9mm	5.1mm	11.8mm	1.0mm	Area: A Unit: 1c Rm: 110 Lot 6892
M21	obsidian	29.0mm	13.9mm	2.6mm	triangular	convex	corner	25.4mm	6.6mm	13.4mm	4.8mm	13.9mm	1.1mm	Area: A Unit: 32 Rm: 83 7003
M3	obsidian	fragment	fragment	fragment	fragment	straight	corner	fragment	4.9mm	fragment	4.3mm	fragment	fragment	Area:A Unit:1A Rm:A5 Lve:1 Lot 258
M4	obsidian	fragment	10.4mm	4.1mm	triangular	fragment	corner	16.0mm	fragment	10.4mm	5.1mm	fragment	fragment	Pot-hunter Fill Under A1 Lot:4402
M5	obsidian	22.2mm	11.8mm	3.2mm	triangular	convex	corner	18.9mm	5.1mm	11.8mm	6.1mm	fragment	fragment	Area:B Surface Lot:2579
M6	chalcedony	27.9mm	14.0mm	2.7mm	triangular	convex	corner	25.7mm	6.8mm	14.0mm	5.7mm	fragment	fragment	Area:B Unit:4 Rm:2 Lot:870
M7	obsidian	fragment	11.0mm	2.9mm	triangular	fragment	corner	15.3mm	fragment	11.0mm	4.9mm	fragment	fragment	Area:A Lot:1A Rm:A5 Fill Lvel:1 Lot:351
M8	chert	19.7mm	12.9mm	3.9mm	triangular	convex	corner	16.9mm	4.5mm	12.9mm	8.0mm	10.9mm	2.1mm	Area:A Lot:5102
M9	rhyolite	19.9mm	12.9mm	2.4mm	triangular	convex	corner	17.8mm	4.5mm	12.9mm	6.4mm	9.0mm	2.7mm	Area:A Unit:22 Rm:A16 Lot:3311
S1	obsidian	15.4mm	8.9mm	2.8mm	triangular	straight	side	11.6mm	5.3mm	8.9mm	5.6mm	fragment	fragment	Area:A Unit:32 Lvl:1 Lot:4101

Appendix A: All measurement are in mm. Specimen numbers also represent point type where M1 = Mimbres Type point number 1, S1 = Swarts Type point number 1, H1 = Hinton Type point number 1, C1 = Cosgrove Type point number 1, A1-1 = A1 Type point number 1, A2-1 = A2 Type point number 1, A3-1 = A3 Type point number 1, A4-1 = A4 Type point number 1, A5-1 = A5 Type point number 1, SP1 = San Pedro Type point number 1, CH1 = Chiricahua Type point number1, D1-1 = D1 Type point number 1, D2-1 = D2 Type point number 1, D4-1 = D4 Type point number 1, and D5-1 = D5 Type point number 1.

APPENDIX A: Descriptive attributes of typable points

Specimen #	Material	Length	Width	Thickness	Shape	Basal Edge Shape	Notch Type	Blade Length	Haft Length	Blade Width	Neck Width	Base Width	SBC	Provenience
S10	obsidian	23.9mm	10.8mm	3.2mm	triangular	straight	side	16.8mm	7.2mm	8.0mm	5.3mm	10.8mm	2.0mm	Area:A Unit:1C Rm:A7 Lot:1537
S11	obsidian	19.6mm	10.2mm	2.9mm	triangular	convex	side	15.4mm	4.9mm	8.6mm	5.9mm	10.2mm	2.3mm	Area:A Surface Lot:29
S12	obsidian	14.4mm	8.9mm	3.1mm	triangular	straight	side	9.9mm	5.3mm	8.9mm	4.9mm	8.9mm	3.9mm	Area:A Unit:1A Rm:A1 Lot:13
S13	obsidian	14.4mm	7.2mm	2.7mm	triangular	straight / slightly concave	side	10.8mm	5.1mm	6.9mm	3.8mm	7.2mm	2.9mm	Area:A Unit:2 Lot:18
S14	obsidian	16.1mm	9.2mm	2.8mm	triangular	straight / slightly convex	side	12.5mm	4.9mm	9.2mm	6.5mm	9.2mm	2.3mm	Area:A Unit:1A Rms:1/5 Lot:190
S15	obsidian	fragment	fragment	fragment	triangular	straight / slightly concave	side	fragment	fragment	fragment	4.8mm	10.5mm	fragment	Area:A Unit:32 Rm:A83 Lot:6078
S16	obsidian	12.3mm	9.5mm	3.3mm	triangular	straight / slightly convex	side	13.1mm	5.1mm	9.5mm	6.0mm	fragment	fragment	Area:A Unit:1A Rm:A5 Lot:97
S17	chert	21.2mm	10.5mm	2.4mm	triangular	straight / slightly convex	side	17.8mm	4.1mm	10.5mm	5.8mm	10.4mm	1.9mm	Area:A Unit:1A Rm:A5 Lvl:1 Lot:579
S18	chert	16.0mm	11.1mm	2.9mm	triangular	straight / slightly concave	side	12.5mm	5.0mm	11.1mm	6.4mm	10.9mm	2.9mm	Area:A Lvl:20 Lot:3909
S19	chert	28.1mm	12.9mm	2.4mm	triangular	straight slightly convex	side	24.3mm	5.1mm	10.0mm	6.4mm	12.9mm	2.1mm	Area:A Unit:22 Lot:3054
S2	obsidian	fragment	11.1mm	3.4mm	triangular	straight	side	fragment	5.8mm	7.2mm	5.1mm	11.1mm	4.4mm	Area:A Unit:32 Lot:3964
S20	obsidian	22.3mm	12.2mm	4.5mm	triangular	straight/ bicurvate	side	18.2mm	5.1mm	10.9mm	7.8mm	12.2mm	3.1mm	Area:A Unit:10 Rm:A107 Lvl:2 Lot:6422
S21	obsidian	15.0mm	fragment	3.1mm	triangular	straight / bicurvate	side	12.7mm	3.7mm	fragment	fragment	fragment	2.3mm	Area:A Unit:7 Feature:A10-12 Lot:1565
S22	obsidian	13.8mm	8.1mm	2.8mm	triangular	straight / bicurvate	side	10.2mm	4.6mm	7.2mm	5.9mm	8.1mm	2.1mm	Area:A Unit:32 Lvl:6 Lot:3453
S23	obsidian	19.5mm	12.6mm	3.4mm	triangular	straicht	side	15.7mm	3.9mm	10.5mm	8.0mm	12.6mm	1.5mm	Area: A Unit: 32 Rm: 83 Lot 6925
S24	obsidian	18.2mm	fragment	3.4mm	triangular	straight	side	13.9mm	5.2mm	fragment	7.3mm	fragment	fragment	Area: A Unit: 1c Rm: 110 Lot 7115
S25	obsidian	16.5mm	9.3mm	3.4mm	triangular	straight	side	11.5mm	4.6mm	6.7mm	5.5mm	9.3mm	2.3mm	Area: A Unit: 1c Rm: 110 Lot 6818
S3	obsidian	16.3mm	9.2mm	3.8mm	triangular	straight / slightly concave	side	10.6mm	5.8mm	6.8mm	5.1mm	9.2mm	4.8mm	Area:A Unit:32 Lot:3853
S4	obsidian	12.8mm	8.7mm	1.9mm	triangular	straight / slightly convex	side	6.6mm	4.9mm	5.2mm	3.9mm	8.7mm	3.1mm	Area:A Unit:2 Lot:3612
S5	obsidian	fragment	fragment	fragment	triangular	fragment	side	12.2mm	fragment	8.1mm	5.2mm	fragment	fragment	Area:A Unit:2 Lot:3554
S6	obsidian	25.6mm	10.2mm	3.6mm	triangular	straight / slightly convex	side	21.7mm	4.2mm	8.9mm	7.6mm	10.2mm	3.3mm	Area:A Unit:2 Lvl:1 Lot:3477
S7	chert	21.3mm	11.4mm	3.1mm	triangular	straight / slightly convex	side	17.2mm	5.1mm	11.4mm	7.2mm	11.1mm	3.1mm	Area:A Unit:2 Lvl:1 Lot:3477
S8	chert	26.1mm	8.9mm	2.3mm	triangular	straight / slightly convex	side	22.7mm	4.1mm	8.9mm	5.7mm	7.1mm	2.1mm	Area:A Unit:22 Lvl:3 Rm:A16 Lot:3099
S9	obsidian	18.2mm	10.1mm	3.4mm	triangular	straight / slightly concave	side	14.2mm	5.1mm	9.8mm	6.6mm	10.1mm	3.2mm	Area:A Unit:22 Rm:A16 Lot:3050

Appendix A: All measurement are in mm. Specimen numbers also represent point type where M1 = Mimbres Type point number 1, S1 = Swarts Type point number 1, H1 = Hinton Type point number 1, C1 = Cosgrove Type point number 1, A1-1 = A1 Type point number 1, A2-1 = A2 Type point number 1, A3-1 = A3 Type point number 1, A4-1 = A4 Type point number 1, A5-1 = A5 Type point number 1, SP1 = San Pedro Type point number 1, CH1 = Chiricahua Type point number1, D1-1 = D1 Type point number 1, D2-1 = D2 Type point number 1, D4-1 = D4 Type point number 1, and D5-1 = D5 Type point number 1.

APPENDIX A: Descriptive attributes of typable points

Specimen #	Material	Length	Width	Thickness	Shape	Basal Edge Shape	Notch Type	Blade Length	Haft Length	Blade Width	Neck Width	Base Width	SBC	Provenience
SP1	chert	fragment	19.4mm	6.8mm	triangular	convex	side / corner	fragment	12.1mm	19.4mm	10.2mm	16.5mm	6.6mm	Area:A Unit:22 Lot:4824
SP2	chalcedony	47.2mm	19.1mm	5.8mm	triangular	convex	side / corner	34.3mm	14.2mm	19.1mm	9.9mm	14.2mm	10.4mm	Area:A Unit:22 Rm.:A16 Lot:3291
SP3	chalcedony	80.7mm	23.3mm	8.2mm	triangular	convex	side / corner	70.8mm	10.2mm	23.3mm	8.9mm	15.1mm	8.8mm	Area:A Unit:1C Rm.: A11 Lot:6366
SP4	chert	37.8mm	18.7mm	6.1mm	triangular	straight / slightly convex	one serrated lateral edge	27.1mm	12.1mm	18.7mm	7.0mm	10.5mm	11.3mm	Area:A Unit:1C Rm.:A112 Lot:6614
SP5	rhyolite	fragment	fragment	fragment	triangular	fragment	one serrated lateral edge	fragment	fragment	fragment	7.8mm	fragment	fragment	Area:B Unit:5 General Surface Collection Lot:888
SP6	chert	fragment	16.8mm	3.6mm	triangular	straight / slightly convex	side / corner	fragment	9.6mm	16.8mm	7.4mm	11.1mm	7.6mm	Area: B Surface Lot: 2058

Appendix A: All measurement are in mm. Specimen numbers also represent point type where M1 = Mimbres Type point number 1, S1 = Swarts Type point number 1, H1 = Hinton Type point number 1, C1 = Cosgrove Type point number 1, A1-1 = A1 Type point number 1, A2-1 = A2 Type point number 1, A3-1 = A3 Type point number 1, A4-1 = A4 Type point number 1, A5-1 = A5 Type point number 1, SP1 = San Pedro Type point number 1, CH1 = Chiricahua Type point number1, D1-1 = D1 Type point number 1, D2-1 = D2 Type point number 1, D4-1 = D4 Type point number 1, and D5-1 = D5 Type point number 1.

APPENDIX B: Elemental Concentrations for analyzed Samples

Sample	Sample Type	Provenience	Ti49 ppm	Mn55 ppm	Fe56 ppm	Rb85 ppm	Sr88 ppm	Y89 ppm	Zr90 ppm	Nb93 ppm	Ba138 ppm	Source
LA635 80.30.233		Galaz Ruin	1484.723	426.091	13404.987	261.431	52.818	37.99	159.395	28.366	241.474	Mule Creek Antelope Cr
LA635 80.30.231	Cosgrove	Galaz Ruin	552.538	389.563	7434.024	264.221	17.893	35.683	102.565	23.308	71.434	Mule Creek Antelope Cr
LA635 80.30.235	A3	Galaz Ruin	441.632	389.202	6736.409	254.129	13.37	38.093	103.627	23.023	61.271	Mule Creek Antelope Cr
LA635 80.30.236	Cosgrove	Galaz Ruin	487.743	389.343	7000.396	255.854	14.27	37.452	103.655	23.295	66.503	Mule Creek Antelope Cr
LA635 80.30.232	Cosgrove	Galaz Ruin	477.677	370.063	7076.983	266.363	13.14	35.337	97.627	23.372	60.801	Mule Creek Antelope Cr
LA635 80.30.234		Galaz Ruin	818.192	352.319	6299.085	237.81	12.469	33.514	90.336	21.943	54.126	Mule Creek Antelope Cr
LA 635 80.30.237	Cosgrove	Galaz Ruin	401.158	342.258	6572.281	235.96	12.209	34.325	100.765	23.409	63.703	Mule Creek Antelope Cr
LA 635 80.30.238	Mimbres	Galaz Ruin	582.107	484.685	5036.813	185.896	6.742	19.47	103.413	27.864	48.106	Mule Creek Mule Mtns
LA 635 80.30.239		Galaz Ruin	410.534	348.893	7126.79	242.157	11.889	35.96	102.586	23.455	61.461	Mule Creek Antelope Cr
LA 635 80.30.240	Cosgrove	Galaz Ruin	401.952	403.031	7373.877	214.814	45.914	33.121	97.148	22.615	103.607	Mule Creek Antelope Cr
LA 635 80.30.241	Cosgrove	Galaz Ruin	436.312	352.583	9491.539	233.767	13.58	30.518	92.604	20.665	58.053	Mule Creek Antelope Cr
LA 635 80.30.243	Cosgrove	Galaz Ruin	472.466	1136.632	25852.716	244.037	14.816	42.183	103.42	24.12	80.867	Mule Creek Antelope Cr
LA 635 80.30.244		Galaz Ruin	421.834	450.89	6625.797	153.152	3.587	18.312	56.386	40.154	10.759	Mule Creek SF River Alluv.
LA 635 80.30.245		Galaz Ruin	389.008	340.289	6685.219	230.639	12.128	34.324	100.835	22.101	61.156	Mule Creek Antelope Cr
LA635 80.30.246		Galaz Ruin	463.128	410.057	9816.021	207.001	17.016	30.841	95.711	20.486	89.496	Mule Creek SF River Alluv.
LA635 80.30.247		Galaz Ruin	375.138	336.59	6250.786	243.952	11.85	33.764	97.34	23.281	56.034	Mule Creek Antelope Cr
LA635 80.30.248		Galaz Ruin	390.247	348.681	6152.532	241.811	11.129	36.867	102.794	24.364	55.99	Mule Creek Antelope Cr
LA635 80.30.249		Galaz Ruin	392.046	505.449	6934.689	211.503	0.36	59.866	168.448	89.348	1.765	Gwynn Canyon
LA635 80.30.250		Galaz Ruin	383.289	350.428	6388.164	236.006	11.317	35.426	100.38	23.655	57.785	Mule Creek Antelope Cr
LA635 80.30.251	Swarts	Galaz Ruin	531.917	433.038	19087.489	242.561	17.647	33.719	97.401	22.497	79.214	Mule Creek Antelope Cr
LA635 80.30.252		Galaz Ruin	395.506	340.026	5823.154	230.001	20.112	36.206	102.803	23.458	69.013	Mule Creek Antelope Cr
LA635 80.30.253		Galaz Ruin	587.493	457.346	4388.944	182.04	6.751	21.046	108.41	27.595	48.798	Mule Creek Mule Mtns
LA635 80.30.254	A3	Galaz Ruin	581.574	474.582	4859.478	163.87	7.489	19.292	104.412	25.623	48.624	Mule Creek Mule Mtns
LA635 80.30.255		Galaz Ruin	388.615	353.916	6291.59	226.61	12.167	35.167	100.661	22.725	59.161	Mule Creek Antelope Cr
LA635 80.30.256		Galaz Ruin	773.624	406.177	5840.005	215.524	13.43	25.93	129.388	20.549	43.09	Gwynn Canyon
LA635 80.30.257	A3	Galaz Ruin	387.529	328.379	6193.353	233.092	12.123	35.305	99.052	22.335	57.577	Mule Creek Antelope Cr
LA635 80.30.258	Mimbres	Galaz Ruin	413.089	363.794	6382.036	221.178	17.153	35.343	101.298	22.324	70.269	Mule Creek Antelope Cr
LA635 80.30.259		Galaz Ruin	384.622	332.887	5938.304	192.47	12.456	30.903	92.699	20.732	58.659	Mule Creek SF River Alluv.
LA635 80.30.260		Galaz Ruin	371.815	315.541	5690.192	228.254	11.378	31.924	92.309	21.915	56.756	Mule Creek Antelope Cr
LA635 80.30.261	A2 / A3	Galaz Ruin	389.687	483.584	14807.808	224.909	11.513	33.409	95.092	21.992	58.069	Mule Creek Antelope Cr
LA635 80.30.262		Galaz Ruin	808.153	259.101	7459.602	299.439	31.651	54.022	146.304	30.908	158.4	Mule Creek Antelope Cr
LA635 80.30.273	Cosgrove	Galaz Ruin	582.013	463.667	4689.152	173.011	7.903	20.099	104.433	26.918	49.464	Mule Creek Mule Mtns
LA676 80.30.786	Hinton	Mattocks Ruin	422.024	312.157	6197.705	199.815	11.302	30.23	89.435	20.562	54.836	Mule Creek SF River Alluv.
LA676 80.30.794	Cosgrove	Mattocks Ruin	611.111	439.156	5073.07	163.038	9.9	18.221	93.689	24.148	54.566	Mule Creek Mule Mtns
LA676 80.30.752	Cosgrove	Mattocks Ruin	374.34	305.494	5486.005	206.858	11.288	30.823	88.72	20.182	55.312	Mule Creek SF River Alluv.
NAN 3:2 (LA73842)		NAN Survey	498.533	422.024	4494.924	166.43	13.751	20.57	87.503	15.865	86.035	Mule Creek SF River Alluv.
NAN 5:-- (LA73823)		NAN Survey	805.533	240.881	7010.653	266.77	31.894	50.749	140.27	29.192	193.758	Mule Creek Antelope Cr
NAN 5:5 (LA73823)		NAN Survey	743.166	346.05	5432.967	205.23	17.021	21.895	114.054	19.221	92.268	Mule Creek Mule Mtns
NAN 17:8-2 (LA73826)		NAN Survey	513.82	428.364	4681.251	169.749	14.343	21.918	91.765	16.404	92.934	Mule Creek SF River Alluv.

Appendix B: Elemental concentrations of analyzed samples and predicted source group as determined by discriminant analysis of Ba, Sr, Rb, and Zr isotopes. All concentrations are in parts per million (ppm) and the number following the element's symbol represents that isotope's atomic weight. Appendix presents concentration data for titanium (Ti), manganese (Mn), Iron (Fe), rubidium (Rb), strontium (Sr), yttrium (Y), zirconium (Zr), niobium (Nb), and barium (Ba).

APPENDIX B: Elemental Concentrations for analyzed Samples

Sample	Sample Type	Provenience	Ti49 ppm	Mn55 ppm	Fe56 ppm	Rb85 ppm	Sr88 ppm	Y89 ppm	Zr90 ppm	Nb93 ppm	Ba138 ppm	Source
NAN 17:8-1 (LA73826)		NAN Survey	386.741	320.193	5784.597	218.955	11.391	34.405	97.023	21.869	56.231	Mule Creek Antelope Cr
NAN 18:8-4 (LA73827)		NAN Survey	123.361	793.039	7215.671	464.577	2.375	57.911	86.572	153.948	13.808	Mule Cr/N Sawmill Cr
NAN 18:Ph. (LA73827)		NAN Survey	406.638	305.633	6392.428	213.013	13.884	30.928	92.989	20.868	60.881	Mule Creek SF River Alluv.
NAN 19:8-5 (LA73828)		NAN Survey	513.899	415.667	4677.955	181.205	14.634	21.435	89.517	16.575	94.766	Mule Creek SF River Alluv.
NAN 22:8-2 (LA73831)		NAN Survey	456.479	316.285	7640.421	220.157	13.892	32.976	101.89	21.381	59.023	Mule Creek Antelope Cr
NAN 27:3 (LA73836)		NAN Survey	467.494	304.089	5766.32	146.347	4.793	33.418	130.779	42.77	33.644	Cow Canyon
NAN 33:1 (LA73842)		NAN Survey	813.72	411.381	5892.974	269.254	18.102	23.001	110.816	19.013	47.088	Mule Creek Antelope Cr
NAN 51:2 (LA73859)		NAN Survey	902.549	528.791	10369.594	200.94	29.219	22.019	100.339	16.704	103.611	Mule Creek SF River Alluv.
NAN 63:5 (LA73871)		NAN Survey	139.968	936.478	8351.522	519.502	7.003	61.831	89.091	150.382	9.646	Mule Cr/N Sawmill Cr
NAN 68:3		NAN Survey	1435.656	999.656	20780.664	336.437	7.408	123.57	1206.281	86.439	7.437	Antelope Wells
NAN 70:1 (LA15059)		NAN Survey	596.411	499.555	5268.325	199.055	20.498	24.315	98.211	17.575	94.402	Mule Creek SF River Alluv.
Lot 879		Old Town Ruin	945.251	1010.354	15309.158	185.424	42.439	26.926	121.688	18.325	66.631	Mule Creek Mule Mtns
Lot 1171		Old Town Ruin	640.738	375.505	16948.044	141.246	35.314	16.442	81.947	12.386	42.701	Mule Creek SF River Alluv.
Lot 1203		Old Town Ruin	760.27	497.823	8943.045	169.948	41.841	22.069	116.573	15.316	55.115	Mule Creek Mule Mtns
Lot 1504		Old Town Ruin	458.634	620.422	12914.762	205.834	18.904	34.605	99.131	20.087	57.527	Mule Creek SF River Alluv.
Lot 3432		Old Town Ruin	591.925	547.836	7490.7	205.755	16.861	24.856	108.299	18.384	91.876	Mule Creek SF River Alluv.
Lot 1410		Old Town Ruin	399.525	518.411	14961.941	193.842	13.135	32.129	85.986	18.795	67.487	Mule Creek SF River Alluv.
Lot 1563		Old Town Ruin	576.505	483.479	5533.176	168.594	26.901	23.597	93.791	15.629	99.503	Mule Creek SF River Alluv.
Lot 1545		Old Town Ruin	796.359	471.461	11633.189	147.542	241.445	29.501	108.88	15.619	262.319	Cow Canyon
Lot #1565	Swarts	Old Town Ruin	562.26	494.99	5367	193.3	17.615	22.664	98.559	17.984	94.011	Mule Creek SF River Alluv.
Lot 1267		Old Town Ruin	815.726	422.479	6430.664	194.022	25.227	25.547	119.161	17.9	48.979	Mule Creek Mule Mtns
Lot 258	Mimbres	Old Town Ruin	798.493	421.167	5989.309	217.812	14.321	24.235	119.339	18.086	41.814	Gwynn Canyon
Lot #683b	Debitage	Old Town Ruin	527.99	457.37	5048.7	176.47	16.314	21.6	83.342	15.475	86.482	Mule Creek SF River Alluv.
Lot #914B	Debitage	Old Town Ruin	407.42	530.33	12047	233.32	14.442	30.987	82.721	20.978	72.835	Mule Creek Antelope Cr
Lot 4402	Mimbres	Old Town Ruin	572.827	467.311	5046.689	189.906	15.782	23.393	94.367	16.775	90.505	Mule Creek SF River Alluv.
Lot 914b	Debitage	Old Town Ruin	400.64	526.78	11956.5	230.255	14.173	30.967	82.5055	20.991	73.1265	Mule Creek Antelope Cr
Lot 1512		Old Town Ruin	751.294	413.453	5756.453	199.457	13.659	24.987	113.866	17.823	38.344	Mule Creek Mule Mtns
Lot #914B	Debitage	Old Town Ruin	393.86	523.23	11866	227.19	13.904	30.947	82.29	21.004	73.418	Mule Creek Antelope Cr
Lot 683	Debitage	Old Town Ruin	549.85	451.635	4969.95	181.46	16.138	21.496	83.6925	15.9515	85.6865	Mule Creek SF River Alluv.
Lot #1581	Hinton	Old Town Ruin	777.17	664.57	11405	125.01	218.4	33.622	101.9	22.739	274.66	Cow Canyon
Lot 1522b		Old Town Ruin	733.285	398.429	5543.059	200.329	13.201	24.134	110.391	17.918	36.229	Mule Creek Mule Mtns
Lot #727 1	Debitage	Old Town Ruin	562.09	442.75	4832.3	166.18	15.572	18.829	73.347	15.77	86.598	Mule Creek SF River Alluv.
Lot #683 1	Debitage	Old Town Ruin	571.71	445.9	4891.2	186.45	15.962	21.392	84.043	16.428	84.891	Mule Creek SF River Alluv.
Lot #914A	Debitage	Old Town Ruin	750.36	397.24	6161.3	196.36	14.83	20.699	99.315	18.527	43.076	Mule Creek SF River Alluv.
Lot 727	Debitage	Old Town Ruin	565.625	438.315	4814.85	172.645	15.5705	19.103	74.81	15.957	85.771	Mule Creek SF River Alluv.
Lot 3853	A2	Old Town Ruin	816.089	424.046	5905.03	229.597	15.926	26.349	124.999	20.526	43.677	Mule Creek Antelope Cr
Lot #727b	Debitage	Old Town Ruin	569.16	433.88	4797.4	179.11	15.569	19.377	76.273	16.144	84.944	Mule Creek SF River Alluv.
Lot 914a	Debitage	Old Town Ruin	757.54	393.675	5921.2	199.005	17.253	21.215	100.6025	18.543	43.8895	Mule Creek SF River Alluv.
Lot 1422		Old Town Ruin	686.031	494.688	6245.194	156.74	29.485	20.519	101.866	23.871	60.98	Mule Creek Mule Mtns
Lot #1067b	Debitage	Old Town Ruin	723.91	378.99	5350.2	196.6	14.607	21.302	100.39	17.819	41.056	Mule Creek SF River Alluv.

Appendix B: Elemental concentrations of analyzed samples and predicted source group as determined by discriminant analysis of Ba, Sr, Rb, and Zr isotopes. All concentrations are in parts per million (ppm) and the number following the element's symbol represents that isotope's atomic weight. Appendix presents concentration data for titanium (Ti), manganese (Mn), Iron (Fe), rubidium (Rb), strontium (Sr), yttrium (Y), zirconium (Zr), niobium (Nb), and barium (Ba).

APPENDIX B: Elemental Concentrations for analyzed Samples

Sample	Sample Type	Provenience	Ti49 ppm	Mn55 ppm	Fe56 ppm	Rb85 ppm	Sr88 ppm	Y89 ppm	Zr90 ppm	Nb93 ppm	Ba138 ppm	Source
Lot #1673a	Debitage	Old Town Ruin	753.27	383.93	5535.3	207.32	14.181	23.058	107.19	18.318	39.61	Mule Creek SF River Alluv.
Lot 330	Mimbres	Old Town Ruin	796.711	397.971	5608.466	213.404	12.832	23.296	110.253	18.945	38.802	Mule Creek SF River Alluv.
Lot 4229	A2	Old Town Ruin	848.133	424.577	5880.125	224.442	15.648	26.129	122.742	20.967	42.609	Gwynn Canyon
Lot #914A	Debitage	Old Town Ruin	764.72	390.11	5681.1	201.65	19.676	21.731	101.89	18.559	44.703	Mule Creek SF River Alluv.
Lot 1067	Debitage	Old Town Ruin	735.9	383.065	5386.25	199.015	14.27	21.87	102.995	18.2725	41.292	Mule Creek SF River Alluv.
Lot #923b	Debitage	Old Town Ruin	741.11	382.38	5456.5	199.86	15.268	21.494	101.3	18.221	40.873	Mule Creek SF River Alluv.
Lot 5143	Nodule	Old Town Ruin	789.997	401.315	5635.312	226.616	13.789	25.379	120.087	20.303	41.416	Mule Creek Antelope Cr
Lot #1067a	Debitage	Old Town Ruin	747.89	387.14	5422.3	201.43	13.933	22.438	105.6	18.726	41.528	Mule Creek SF River Alluv.
Lot 923	Debitage	Old Town Ruin	733.525	376.06	5285.6	202.165	15.512	22.209	103.86	18.136	40.9205	Mule Creek SF River Alluv.
Lot 1673	Debitage	Old Town Ruin	753.5	380.855	5535.85	204.825	14.2205	23.1405	104.88	17.9925	39.492	Mule Creek SF River Alluv.
Lot #1673b	Debitage	Old Town Ruin	753.73	377.78	5536.4	202.33	14.26	23.223	102.57	17.667	39.374	Mule Creek SF River Alluv.
Lot #2656a	Debitage	Old Town Ruin	760.03	388.16	5493.7	208.03	14.59	22.341	104.59	19.262	40.377	Mule Creek SF River Alluv.
Lot #923a	Debitage	Old Town Ruin	725.94	369.74	5114.7	204.47	15.756	22.924	106.42	18.051	40.968	Mule Creek SF River Alluv.
Lot 2656	Debitage	Old Town Ruin	753.545	385.87	5481.45	207.04	15.567	22.44	104.105	19.1105	40.148	Mule Creek SF River Alluv.
Lot #2656b	Debitage	Old Town Ruin	747.06	383.58	5469.2	206.05	16.544	22.539	103.62	18.959	39.919	Mule Creek SF River Alluv.
Lot 797		Old Town Ruin	881.291	456.592	12429.934	220.8	87.816	35.055	106.292	20.727	88.822	Mule Creek Antelope Cr
Lot 3099a	Cosgrove	Old Town Ruin	368.139	424.742	10152.285	233.738	11.311	33.195	94.27	20.309	52.044	Mule Creek Antelope Cr
Lot #829	Hinton	Old Town Ruin	455.14	531.16	12229	239.5	17.145	39.037	93.947	22.85	63.332	Mule Creek Antelope Cr
Lot 95	Cosgrove	Old Town Ruin	601.361	491.731	5134.804	187.094	6.959	20.669	102.862	26.762	47.177	Mule Creek Mule Mtns
Lot 3624	A4	Old Town Ruin	595.774	469.559	4724.375	173.325	6.461	19.413	95.806	26.22	44.582	Mule Creek Mule Mtns
Lot 4279	A2	Old Town Ruin	650.063	499.583	4783.028	184.645	10.147	21.582	106.21	27.825	49.69	Mule Creek Mule Mtns
Lot 1745	A3	Old Town Ruin	605.13	471.41	4629.116	186.678	6.764	20.067	98.207	26.172	45.721	Mule Creek SF River Alluv.
Lot 1537		Old Town Ruin	405.095	349.99	6649.99	206.935	13.252	35.177	96.187	20.19	54.235	Mule Creek SF River Alluv.
Lot 6001	A5	Old Town Ruin	604.744	433.873	5137.083	201.557	12.963	24.3	111.218	25.218	61.182	Mule Creek Mule Mtns
Lot#1637	Hinton	Old Town Ruin	466.83	420.8	8512	234.97	23.807	33.878	102.65	21.599	78.271	Mule Creek Antelope Cr
Lot 5103	A4	Old Town Ruin	634.439	477.948	4779.257	184.219	7.258	21.134	102.782	27.698	47.71	Mule Creek Mule Mtns
Lot 2413	Mimbres	Old Town Ruin	420.761	397.351	9446.585	246.612	11.502	33.191	90.215	21.209	53.569	Mule Creek Antelope Cr
Lot 3347	Cosgrove	Old Town Ruin	384.023	417.357	8837.71	229.632	11.151	31.967	87.156	21.476	52.353	Mule Creek Antelope Cr
Lot 24	Cosgrove	Old Town Ruin	682.324	381.74	10506.23	224.418	15.645	33.226	101.622	22.69	58.495	Mule Creek Antelope Cr
Lot 1637		Old Town Ruin	413.864	375.441	7985.068	205.397	43.465	35.319	96.158	19.793	56.376	Mule Creek SF River Alluv.
Lot 13	A3	Old Town Ruin	443.028	552.93	7541.697	197.29	0.666	60.757	166.972	85.374	1.945	Gwynn Canyon
Lot 1533		Old Town Ruin	377.983	346.187	6874.921	193.575	12.18	32.089	88.181	18.934	52.747	Mule Creek SF River Alluv.
Lot 1522c		Old Town Ruin	421.794	396.483	6515.194	206.982	19.545	35.817	100.529	20.147	64.294	Mule Creek SF River Alluv.
Lot 6679	Cosgrove	Old Town Ruin	390.572	352.763	8550.268	237.916	12.306	32.516	92.492	21.885	55.771	Mule Creek Antelope Cr
Lot 3602		Old Town Ruin	490.952	393.363	6803.102	234.937	34.244	37.118	125.388	24.558	68.264	Mule Creek Antelope Cr
Lot 1501		Old Town Ruin	384.042	333.926	7468.269	204.238	12.08	32.562	89.814	19.602	52.276	Mule Creek SF River Alluv.
Lot 4021		Old Town Ruin	415.419	369.061	7510.326	216.676	17.073	35.933	97.575	20.567	57.759	Mule Creek SF River Alluv.
Lot #97	Swarts	Old Town Ruin	522.96	400.08	7452.9	261.09	64.856	32.446	96.232	22.357	96.396	Mule Creek Antelope Cr
Lot 3580		Old Town Ruin	384.45	376.534	6401.792	195.56	12.067	35.689	96.204	20.35	50.259	Mule Creek SF River Alluv.
Lot 3763		Old Town Ruin	385.866	378.739	8401.188	212.315	11.158	37.029	95.382	21.39	49.558	Mule Creek SF River Alluv.

Appendix B: Elemental concentrations of analyzed samples and predicted source group as determined by discriminant analysis of Ba, Sr, Rb, and Zr isotopes. All concentrations are in parts per million (ppm) and the number following the element's symbol represents that isotope's atomic weight. Appendix presents concentration data for titanium (Ti), manganese (Mn), Iron (Fe), rubidium (Rb), strontium (Sr), yttrium (Y), zirconium (Zr), niobium (Nb), and barium (Ba).

APPENDIX B: Elemental Concentrations for analyzed Samples

Sample	Sample Type	Provenience	Ti49 ppm	Mn55 ppm	Fe56 ppm	Rb85 ppm	Sr88 ppm	Y89 ppm	Zr90 ppm	Nb93 ppm	Ba138 ppm	Source
Lot #3477	Swarts	Old Town Ruin	581.58	395.99	8738.4	250.73	31.981	34.619	98.98	23.363	76.874	Mule Creek Antelope Cr
Lot #13	Swarts	Old Town Ruin	367.67	346.65	6589.6	233.89	14.534	31.763	91.11	21.206	59.453	Mule Creek Antelope Cr
Lot 1537	A4	Old Town Ruin	610.134	473.946	4783.593	177.917	6.9	19.602	96.262	26.625	46.796	Mule Creek SF River Alluv.
Lot #3050a	Swarts	Old Town Ruin	387.75	364.82	6685.5	232.38	13.688	36.006	102.74	21.492	62.448	Mule Creek Antelope Cr
Lot 1659		Old Town Ruin	448.265	390.062	7405.809	261.954	18.904	38.463	104.976	21.911	64.81	Mule Creek Antelope Cr
Lot 2896	Mimbres	Old Town Ruin	417.034	348.268	6452.055	233	12.052	33.975	96.221	21.247	57.451	Mule Creek Antelope Cr
Lot 3794b	Cosgrove	Old Town Ruin	418.4	353.89	6887.034	227.76	20.751	35.495	97.92	20.958	59.771	Mule Creek Antelope Cr
Lot #7115	Swarts	Old Town Ruin	392.73	379.12	7383.8	247.59	20.577	36.678	98.574	22.337	67.539	Mule Creek Antelope Cr
Lot 1522a		Old Town Ruin	396.074	352.29	6493.463	204.372	12.47	35.283	96.241	20.445	57.168	Mule Creek SF River Alluv.
Lot 3926	Mimbres	Old Town Ruin	408.719	342.737	6095.741	230.16	11.366	32.36	91.262	20.928	53.867	Mule Creek Antelope Cr
Lot 3195	Mimbres	Old Town Ruin	426.173	339.399	6510.124	238.812	12.453	32.77	92.774	21.664	58.985	Mule Creek Antelope Cr
Lot 1976	Debitage	Old Town Ruin	414.11	350.455	6517.2	235.49	16.6335	32.968	88.712	21.3	57.28	Mule Creek Antelope Cr
Lot#1976a	Debitage	Old Town Ruin	432.61	360.15	6444.6	231.77	19.282	32.542	90.962	21.991	61.139	Mule Creek Antelope Cr
Lot 3200	Cosgrove	Old Town Ruin	423.249	345.082	6426.255	223.795	12.315	32.773	93.731	21.95	55.305	Mule Creek Antelope Cr
Lot 3658	A4	Old Town Ruin	382.08	343.044	6399.111	250.814	11.524	33.528	92.903	21.708	53.82	Mule Creek Antelope Cr
Lot 4321	Cosgrove	Old Town Ruin	424.279	337.719	6776.139	242.077	12.537	32.644	92.361	21.901	58.078	Mule Creek Antelope Cr
Lot 3441	A3	Old Town Ruin	425.139	362.031	6666.193	242.725	12.258	33.879	94.698	22.308	59.611	Mule Creek Antelope Cr
Lot 1777		Old Town Ruin	386.077	350.682	6027.207	203.106	12.086	34.767	93.738	20.651	52.103	Mule Creek SF River Alluv.
Lot#1976b	Debitage	Old Town Ruin	395.61	340.76	6589.8	239.21	13.985	33.394	86.462	20.609	53.421	Mule Creek Antelope Cr
Lot 3477	Cosgrove	Old Town Ruin	416.096	358.921	6376.349	231.085	12.262	36.248	101.583	22.236	59.457	Mule Creek Antelope Cr
Lot 1523	A4	Old Town Ruin	411.689	376.522	7111.344	244.243	11.266	35.638	96.779	23.423	52.451	Mule Creek Antelope Cr
Lot 757		Old Town Ruin	407.52	326.05	7604.098	220.166	27.276	36.756	100.299	21.015	104.461	Mule Creek Antelope Cr
Lot 1561	Cosgrove	Old Town Ruin	412.843	356.15	6377.964	232.308	12.488	35.532	98.159	21.858	55.894	Mule Creek Antelope Cr
Lot 3738		Old Town Ruin	438.453	384.281	6860.513	247.257	13.16	37.284	101.413	22.78	61.342	Mule Creek Antelope Cr
Lot 3468		Old Town Ruin	471.471	368.896	7029.215	254.976	13.051	36.181	99.094	23.199	59.23	Mule Creek Antelope Cr
Lot #6818	Swarts	Old Town Ruin	430.81	357.13	6950.3	237.12	15.464	37.331	105.84	23.025	66.291	Mule Creek Antelope Cr
Lot 3035	A3	Old Town Ruin	424.816	352.442	6354.657	232.102	12.599	35.819	100.323	22.045	62.668	Mule Creek Antelope Cr
Lot #3453	Swarts	Old Town Ruin	418.4	363.83	6759.1	259.15	12.526	33.664	93.115	23.548	55.795	Mule Creek Antelope Cr
Lot 4222	Cosgrove	Old Town Ruin	427.382	349.631	6564.636	231.35	12.758	34.42	96.273	22.449	60.538	Mule Creek Antelope Cr
Lot 6892	Mimbres	Old Town Ruin	409.299	334.996	6125.007	232.652	12.221	33.606	92.62	21.521	54.996	Mule Creek Antelope Cr
Lot #1537	Swarts	Old Town Ruin	411.46	351.58	6730.7	240.84	12.749	31.789	88.573	23.442	57.632	Mule Creek Antelope Cr
Lot 3794a	Cosgrove	Old Town Ruin	402.348	325.661	6324.716	242.662	11.054	31.459	85.862	21.563	51.171	Mule Creek Antelope Cr
Lot 1736	A1	Old Town Ruin	426.783	347.13	6412.927	227.645	11.934	33.967	94.378	22.678	54.449	Mule Creek Antelope Cr
Lot 2579	Mimbres	Old Town Ruin	418.193	345.977	6233.734	236.267	11.63	33.978	92.546	22.036	53.759	Mule Creek Antelope Cr
Lot #6078	Swarts	Old Town Ruin	436.98	367.28	6605.8	245.26	14.388	35.741	100.51	23.408	62.641	Mule Creek Antelope Cr
Lot #29	Swarts	Old Town Ruin	422.06	376.87	6724.5	241.76	12.365	33.673	93.289	24.555	56.27	Mule Creek Antelope Cr
Lot #4101	Swarts	Old Town Ruin	428.97	351.9	6309	239.35	12.913	33.182	92.718	23.158	57.938	Mule Creek Antelope Cr
Lot #1894	Hinton	Old Town Ruin	431	354.88	6589.1	252.86	13.264	34.456	94.984	23.073	58.335	Mule Creek Antelope Cr
Lot 1647	A3	Old Town Ruin	410.867	356.385	6400.28	234.625	12.915	35.341	95.859	22.322	54.764	Mule Creek Antelope Cr
Lot 6943	Cosgrove	Old Town Ruin	440.327	356.829	7004.195	239.796	13.377	36.679	100.519	23.47	58.576	Mule Creek Antelope Cr
Lot 1501	Cosgrove	Old Town Ruin	412.118	335.068	6357.188	223.401	12.202	33.469	93.686	22.43	56.366	Mule Creek Antelope Cr

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APPENDIX B: Elemental Concentrations for analyzed Samples

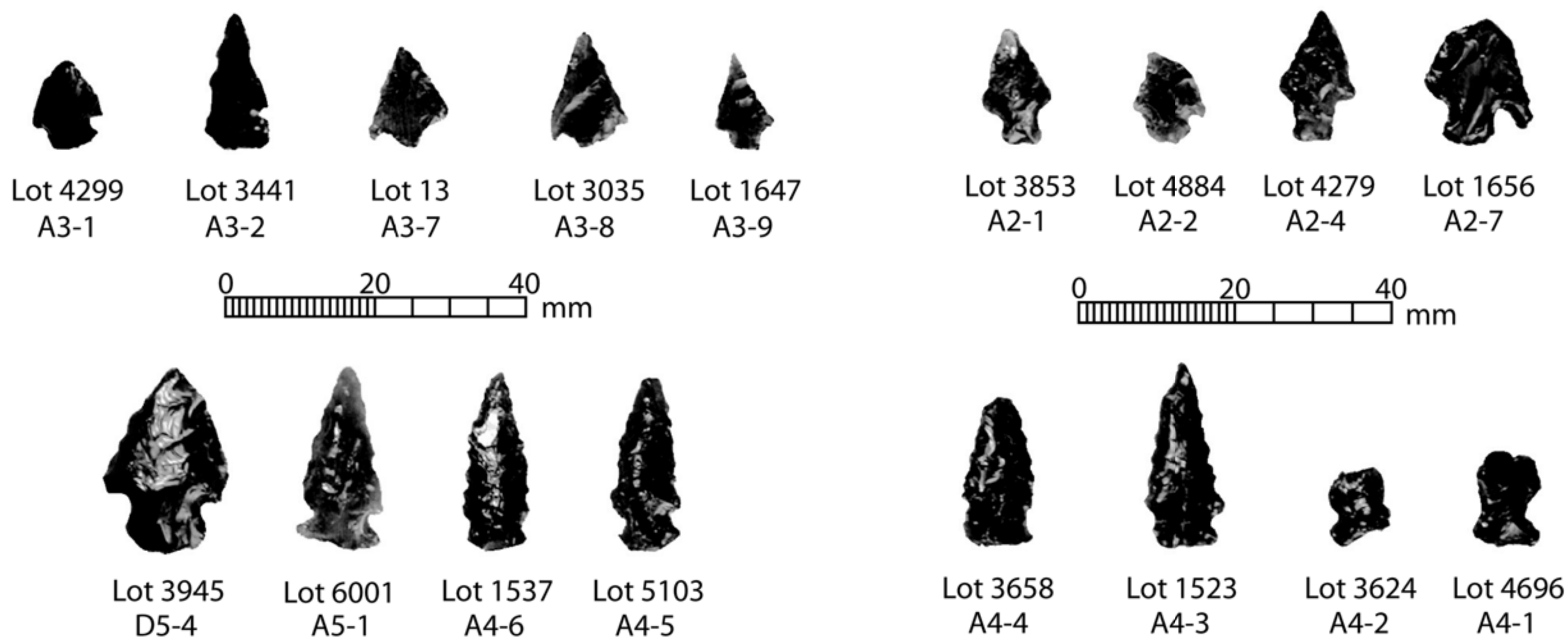
Sample	Sample Type	Provenience	Ti49 ppm	Mn55 ppm	Fe56 ppm	Rb85 ppm	Sr88 ppm	Y89 ppm	Zr90 ppm	Nb93 ppm	Ba138 ppm	Source
Lot 13a	Cosgrove	Old Town Ruin	425.368	361.655	6859.043	248.341	12.39	36.27	99.644	23.257	56.916	Mule Creek Antelope Cr
Lot #3612	Swarts	Old Town Ruin	422.41	367.62	6689.9	247.21	15.671	37.425	103.19	23.276	65.006	Mule Creek Antelope Cr
Lot #3964	Swarts	Old Town Ruin	422.93	356.8	6437.2	245.57	12.285	33.559	90.778	22.86	54.07	Mule Creek Antelope Cr
Lot #3853	Swarts	Old Town Ruin	429.74	367.09	6676.2	254.8	14.458	36.255	99.113	23.416	59.557	Mule Creek Antelope Cr
Lot 4192	A2	Old Town Ruin	448.753	339.186	6169.396	254.701	14.204	33.821	95.684	22.344	75.396	Mule Creek Antelope Cr
Lot 3099	Cosgrove	Old Town Ruin	422.199	338.546	5832.059	235.501	12.449	34.557	95.706	22.248	58.825	Mule Creek Antelope Cr
Lot 3619	Cosgrove	Old Town Ruin	403.865	340.625	5974.755	232.807	11.464	34.782	95.544	21.907	54.586	Mule Creek Antelope Cr
Lot 4553	Cosgrove	Old Town Ruin	426.15	357.085	6542.03	246.525	12.28	36.209	98.382	23.227	56.621	Mule Creek Antelope Cr
Lot 3223	Cosgrove	Old Town Ruin	426.081	358.733	6604.157	247.964	12.762	36.951	101.425	23.303	58.562	Mule Creek Antelope Cr
Lot 7003	Mimbres	Old Town Ruin	418.984	321.063	5577.106	237.719	12.656	33.602	94.034	21.633	57.133	Mule Creek Antelope Cr
Lot #190	Swarts	Old Town Ruin	439.41	352.76	6515.1	235.99	13.922	36.058	99.494	23.333	60.47	Mule Creek Antelope Cr
Lot #3554	Swarts	Old Town Ruin	413.33	373.25	6649	251.13	12.29	37.86	101.76	24.013	56.163	Mule Creek Antelope Cr
Lot #6925	Swarts	Old Town Ruin	420.65	357.96	6683.6	247.29	13.055	37.288	101.38	23.912	58.13	Mule Creek Antelope Cr
Lot #3050	Hinton	Old Town Ruin	427.86	377.5	6627.6	247.77	12.714	38.199	102.13	24.512	56.459	Mule Creek Antelope Cr
Lot 1656	A2	Old Town Ruin	431.732	349.642	5752.271	241.048	11.915	35.118	96.347	23.345	56.388	Mule Creek Antelope Cr
Lot 6106	Mimbres	Old Town Ruin	842.557	280.757	7860.818	307.877	31.503	51.991	134.099	28.943	142.638	Mule Creek Antelope Cr
Lot 4884	A2	Old Town Ruin	530.5	391.413	7099.95	159.183	4.184	39.792	151.249	47.189	27.396	Cow Canyon
Lot 4696	A4	Old Town Ruin	878.684	281.392	7793.112	306.624	34.446	55.424	149.563	30.476	159.706	Mule Creek Antelope Cr
Lot 3945	D5	Old Town Ruin	929.103	291.902	8138.037	307.736	34.974	57.567	154.309	32.527	168.259	Mule Creek Antelope Cr
Lot 351	Mimbres	Old Town Ruin	680.001	617.312	5950.645	165.877	15.746	30.758	65.674	46.567	22.906	Mule Creek SF River Alluv.
Lot# 719a	Debitage	Old Town Ruin	418.46	484.17	7099.4	180.79	11.166	49.097	133.89	72.953	7.4262	Mule Creek Mule Mtns
Lot 719	Debitage	Old Town Ruin	408.545	484.655	6967.9	181.98	7.3877	49.483	134.635	72.972	5.24185	Mule Creek Mule Mtns
Lot# 719b	Debitage	Old Town Ruin	398.63	485.14	6836.4	183.17	3.6094	49.869	135.38	72.991	3.0575	Mule Creek Mule Mtns
Lot 6885	Mimbres	Old Town Ruin	418.203	516.823	7281.381	201.026	3.031	53.371	146.868	78.236	3.508	Mule Creek Mule Mtns
Lot 3539	Mimbres	Old Town Ruin	417.573	510.642	7214.976	201.641	0.3	54.146	148.775	79.074	1.716	Mule Creek Mule Mtns
Lot 4299	A3	Old Town Ruin	407.3	519.636	7034.243	201.606	0.717	55.347	150.521	79.107	1.724	Gwynn Canyon
Lot 13	Cosgrove	Old Town Ruin	416.651	383.846	8262.395	239.169	12.478	33.203	93.911	21.97	59.601	Mule Creek Antelope Cr
Lot #6422	Swarts	Old Town Ruin	446.97	676.62	7113.2	200.1	741.48	57.161	161.91	79.969	326.85	Mule Creek Antelope Cr
Lot 2921	Cosgrove	Old Town Ruin	361.562	617.426	4930.814	411.784	2.969	58.965	86.93	98.011	5.526	Mule Cr/N Sawmill Cr
LA12076 80.30.335		Poe Ruin	1470.977	380.477	17981.666	234.97	41.507	38.139	140.37	22.565	144.833	Gwynn Canyon
LA12076 80.30.336	Swarts	Poe Ruin	445.998	1508.439	67603.249	203.792	12.145	32.257	91.067	21.317	54.493	Mule Creek SF River Alluv.
LA12076 80.30.337		Poe Ruin	373.743	570.562	12632.968	235.215	10.663	36.781	90.099	21.266	53.139	Mule Creek Antelope Cr
LA12076 80.30.338	A3 / Swarts	Poe Ruin	385.573	339.737	6722.429	236.109	11.49	35.163	100.431	22.774	57.364	Mule Creek Antelope Cr
LA12076 80.30.340	Hinton	Poe Ruin	385.78	346.462	6286.237	216.858	11.825	35.153	100.604	22.723	60.026	Mule Creek SF River Alluv.
25-11-10 : 95067.1		Swarts Ruin	452.612	395.341	12500.381	238.039	16.862	31.278	90.994	20.028	59.505	Mule Creek Antelope Cr
25-11-10 : 95068.3	Swarts	Swarts Ruin	831.108	714.539	12891.039	232.248	18.053	25.465	118.564	18.811	41.979	Mule Creek Antelope Cr
25-11-10 : 95068.5		Swarts Ruin	815.176	423.947	5997.883	234.804	17.446	24.581	115.099	19.266	40.143	Mule Creek Antelope Cr
25-11-10 : 95068.6	Cosgrove	Swarts Ruin	435.72	402.921	6853.481	299.603	40.842	35.169	96.206	22.057	72.394	Mule Creek Antelope Cr
25-11-10 : 95068.7	Cosgrove	Swarts Ruin	426.865	362.854	6743.072	238.654	16.216	34.936	96.707	21.702	55.933	Mule Creek Antelope Cr
25-11-10 : 95068.8		Swarts Ruin	431.307	876.549	26205.735	247.994	16.502	36.348	96.161	22.282	58.434	Mule Creek Antelope Cr
26-7-10 : 95675.2	A5	Swarts Ruin	430.389	365.99	7907.885	244.249	16.652	33.041	94.288	21.735	59.634	Mule Creek Antelope Cr

Appendix B: Elemental concentrations of analyzed samples and predicted source group as determined by discriminant analysis of Ba, Sr, Rb, and Zr isotopes. All concentrations are in parts per million (ppm) and the number following the element's symbol represents that isotope's atomic weight. Appendix presents concentration data for titanium (Ti), manganese (Mn), Iron (Fe), rubidium (Rb), strontium (Sr), yttrium (Y), zirconium (Zr), niobium (Nb), and barium (Ba).

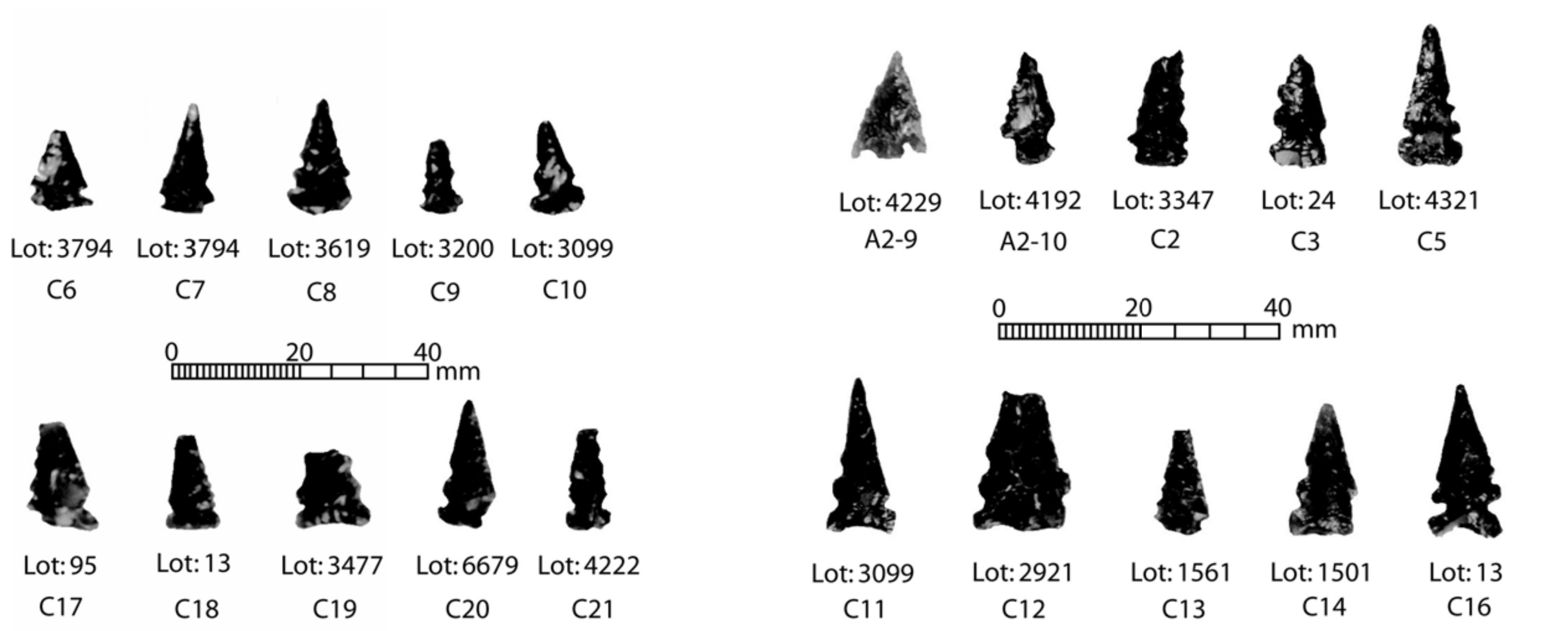
APPENDIX B: Elemental Concentrations for analyzed Samples

Sample	Sample Type	Provenience	Ti49 ppm	Mn55 ppm	Fe56 ppm	Rb85 ppm	Sr88 ppm	Y89 ppm	Zr90 ppm	Nb93 ppm	Ba138 ppm	Source
27-11-10 : 96388.3	Cosgrove	Swarts Ruin	409.227	422.691	19974.116	252.587	17.608	33.435	92.976	21.717	58.046	Mule Creek Antelope Cr
25-11-10 : 95068.2		Swarts Ruin	418.068	372.239	6676.842	237.997	15.877	34.223	93.346	21.911	58.012	Mule Creek Antelope Cr
25-11-10 : 95068.4	Cosgrove	Swarts Ruin	609.82	509.927	5386.257	201.643	20.478	23.844	95.172	17.831	96.94	Mule Creek SF River Alluv.
25-11-10 : 95068.9	Swarts	Swarts Ruin	422.639	359.85	6741.644	215.202	16.932	34.259	95.252	20.898	59.43	Mule Creek SF River Alluv.
25-11-10 : 95068.10	Swarts	Swarts Ruin	440.981	375.013	6926.009	240.925	16.551	35.792	98.918	22.866	59.743	Mule Creek Antelope Cr
25-11-10 : 95068.11		Swarts Ruin	414.205	359.462	6727.826	219.825	17.206	34.291	96.695	20.811	59.439	Mule Creek Antelope Cr
25-11-10 : 95068.12	Swarts	Swarts Ruin	423.765	377.949	6940.411	237.242	19.854	35.123	94.897	22.04	58.182	Mule Creek Antelope Cr
27-11-10 : 96388.1		Swarts Ruin	429.347	379.651	6937.139	239.818	16.632	36.064	99.272	22.468	58.932	Mule Creek Antelope Cr
27-11-10 : 96388.2		Swarts Ruin	575.371	480.016	5279.078	167.845	11.408	18.023	92.254	24.53	43.614	Mule Creek SF River Alluv.
27-11-10 : 96388.4	A1 / A3	Swarts Ruin	421.832	371.706	6751.282	231.012	16.393	34.935	98.15	22.004	57.797	Mule Creek Antelope Cr
25-11-10 : 95067.2		Swarts Ruin	373.578	329.397	6254.427	225.868	15.32	30.229	84.391	19.946	53.271	Mule Creek Antelope Cr
25-11-10 : 95067.3		Swarts Ruin	382.357	425.276	10002.468	227.834	16.393	32.175	88.305	20.4	54.111	Mule Creek Antelope Cr
25-11-10 : 95067.4	Cosgrove	Swarts Ruin	573.207	459.079	6709.606	150.266	77.378	15.56	66.025	12.891	790.914	Mule Creek SF River Alluv.
25-11-10 : 95067.5	A1	Swarts Ruin	412.845	365.125	6747.236	238.331	16.382	34.995	94.537	21.914	63.652	Mule Creek Antelope Cr
25-11-10 : 95068.13	Swarts	Swarts Ruin	441.864	359.817	6599.291	230.216	15.52	32.522	90.565	21.281	54.481	Mule Creek Antelope Cr
25-11-10 : 95075	A3	Swarts Ruin	399.679	601.244	13195.074	238.764	15.981	34.687	93.337	21.171	56.616	Mule Creek Antelope Cr
29-20-10 : 97546	Swarts	Swarts Ruin	386.702	378.714	7209.927	235.079	15.751	35.62	93.487	21.736	51.433	Mule Creek Antelope Cr
Z:13:21 80.30.779	A2	Z:13:21	509.198	1333.044	15110.826	271.366	1.241	61.873	171.378	38.378	3.898	Gwynn Canyon
Z:13:16 80.30.763	D4	Z:13:16	812.1	445.514	6575.954	175.359	9.767	19.624	110.106	26.09	55.686	Mule Creek Mule Mtns
Z:5:10 80.30.772	Hinton	Z:5:10	483.57	398.697	4173.646	133.848	70.931	15.058	66.28	13.017	752.407	Mule Creek SF River Alluv.
Z:5:86 80.30.776	Hinton	Z:5:86	346.798	307.008	7070.151	214.147	10.293	29.937	88.147	20.876	52.976	Mule Creek SF River Alluv.

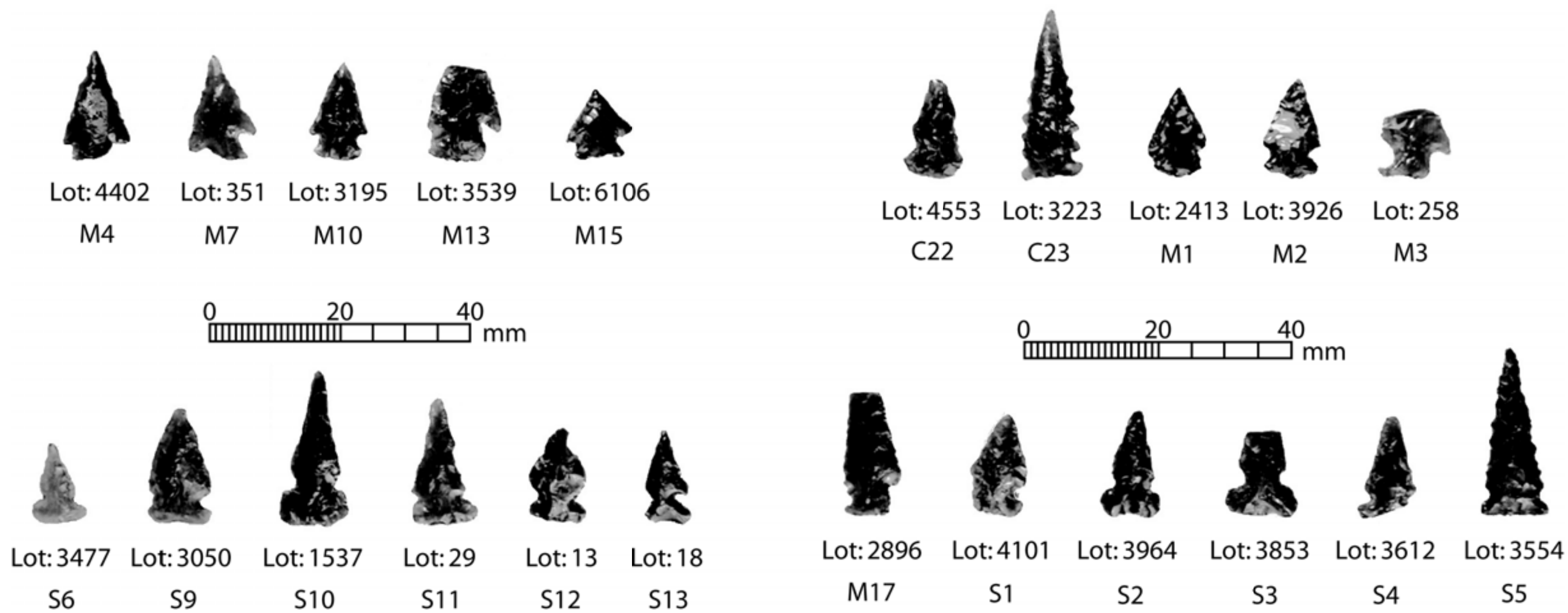
Appendix B: Elemental concentrations of analyzed samples and predicted source group as determined by discriminant analysis of Ba, Sr, Rb, and Zr isotopes. All concentrations are in parts per million (ppm) and the number following the element's symbol represents that isotope's atomic weight. Appendix presents concentration data for titanium (Ti), manganese (Mn), Iron (Fe), rubidium (Rb), strontium (Sr), yttrium (Y), zirconium (Zr), niobium (Nb), and barium (Ba).



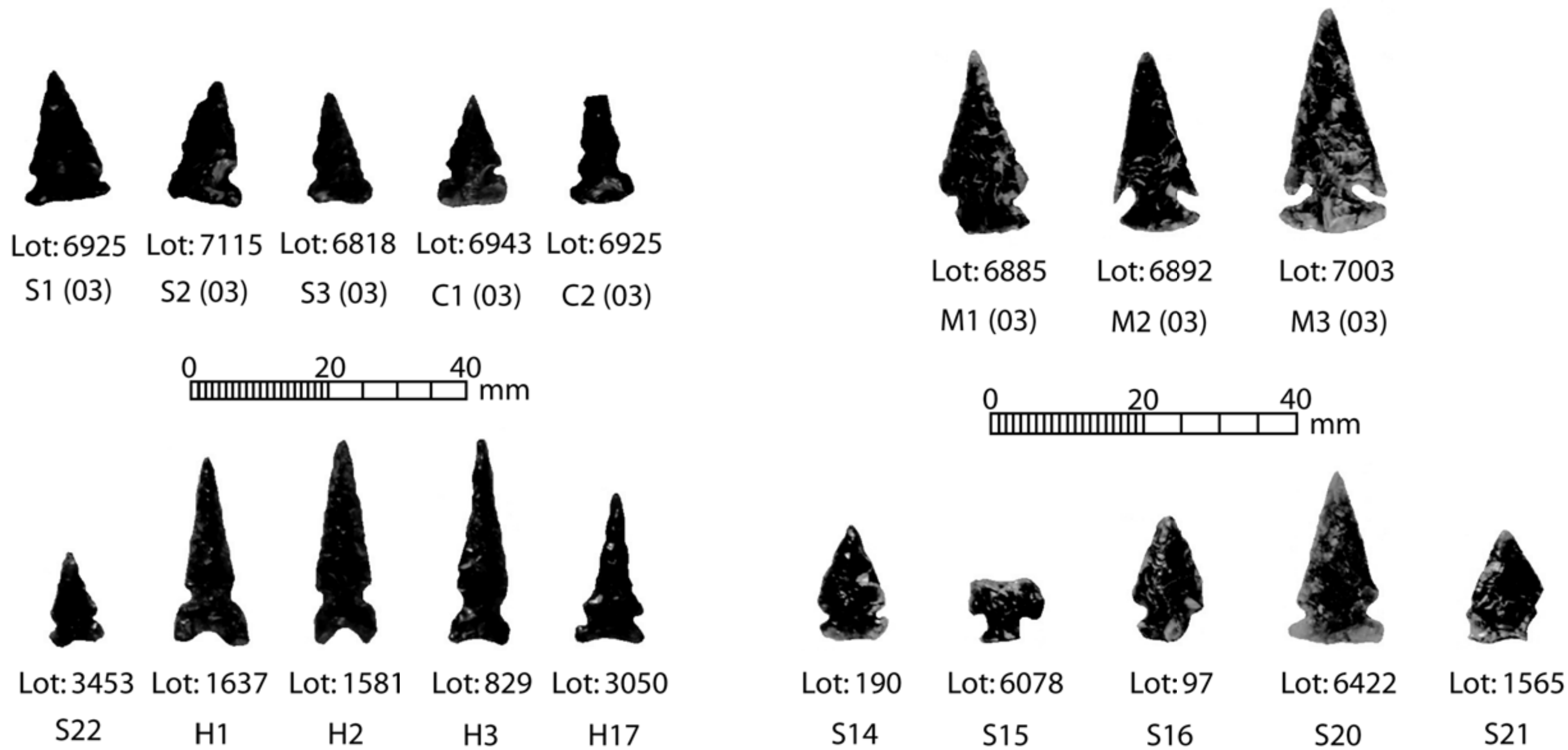
Appendix C: Obsidian points submitted for chemical characterizatiaon



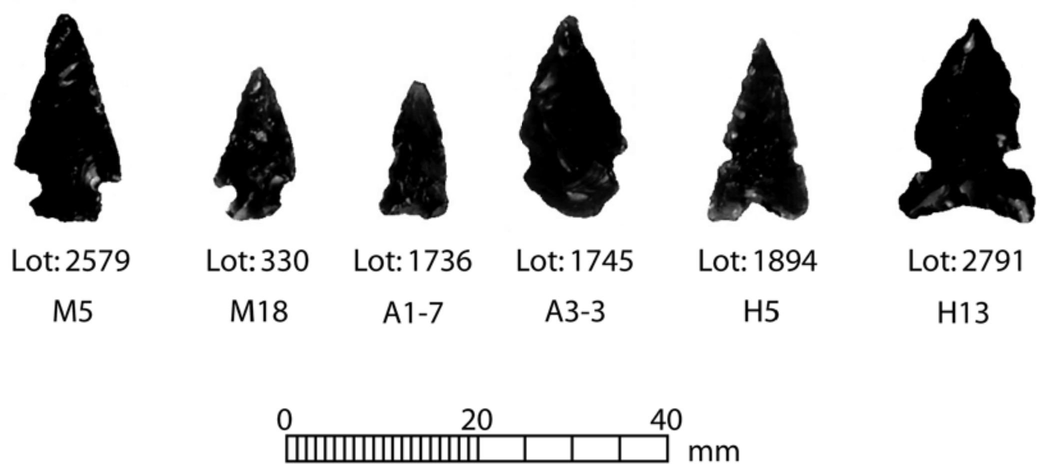
Appendix C: Obsidian points submitted for shemical characterization



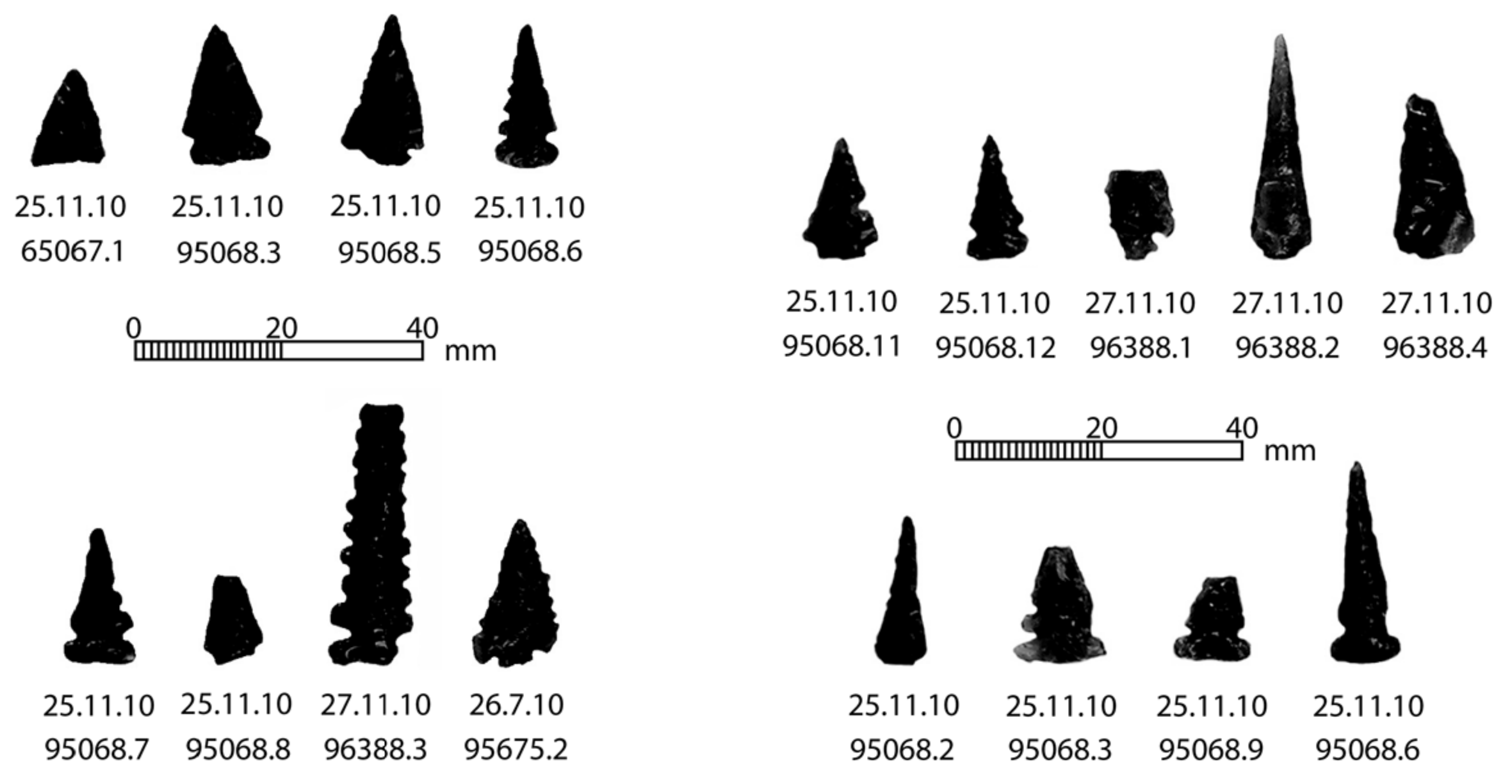
Appendix C: Obsidian points submitted for chamical characterization



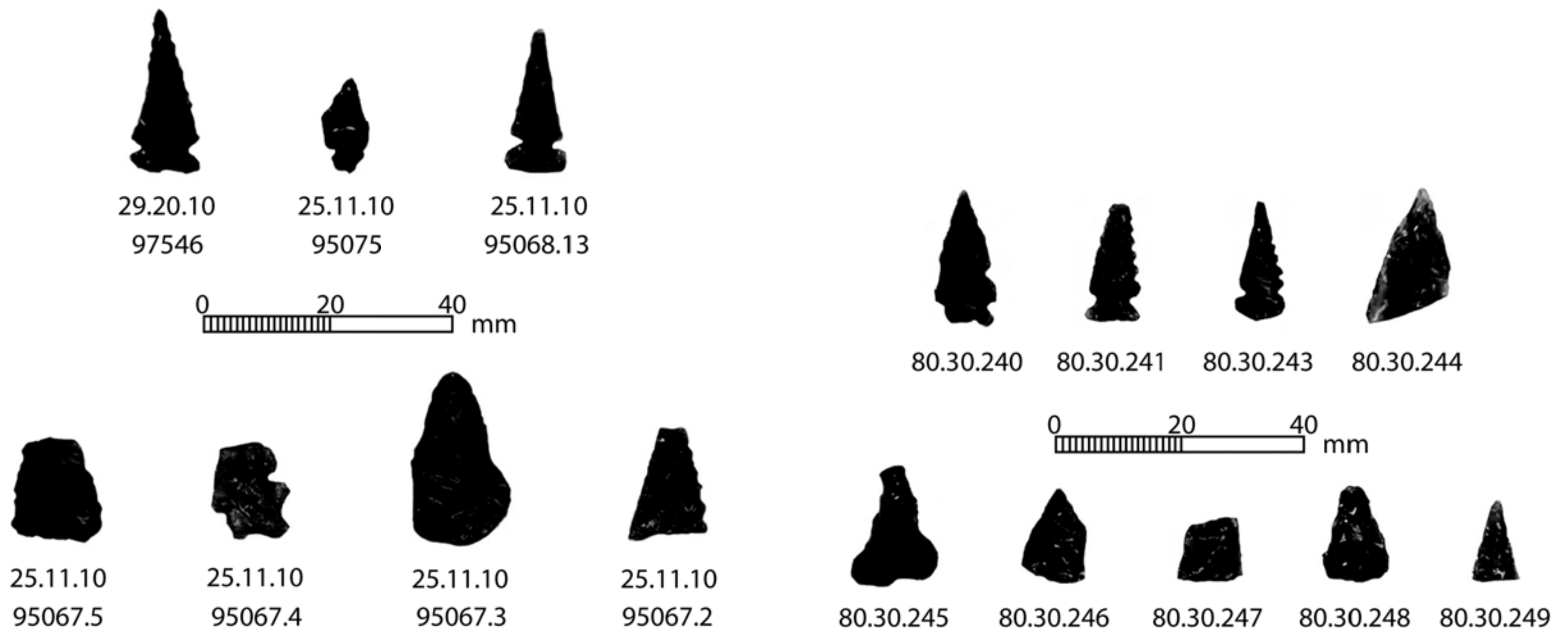
Appendix C: Obsidian pointssubmitted for chemical characterization



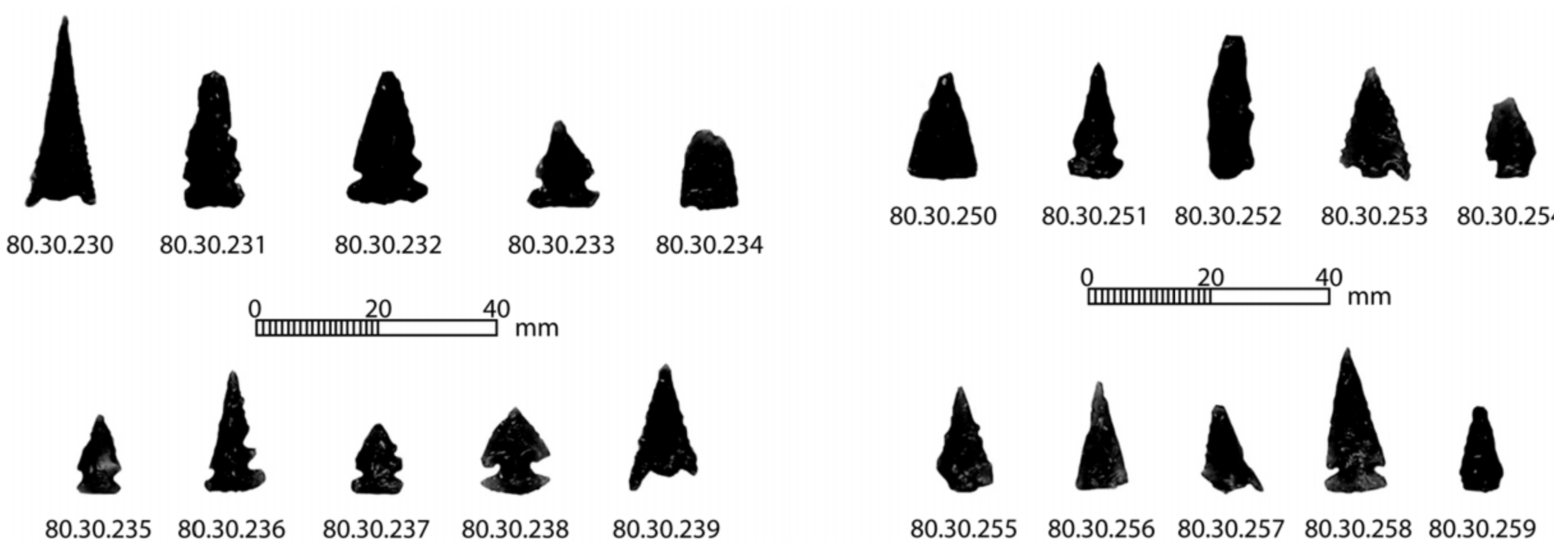
Appendix C: Obsidian points submitted for chemical characterization



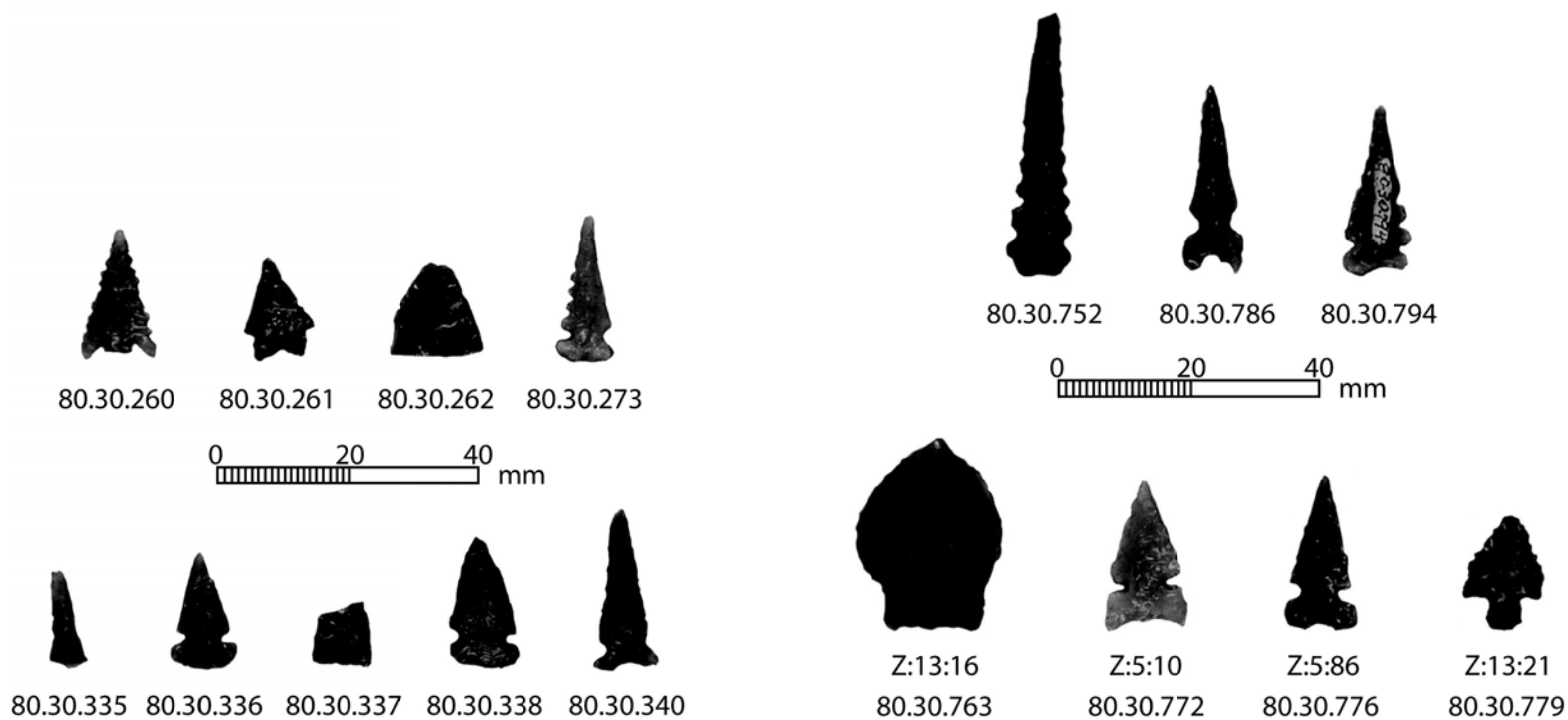
Appendix C: Obsidian points submitted for chemical characterization



Appendix C: Obsidian points submitted for shemical characterization



Appendix C: Obsidian points submitted for chemical characterization



Appendix C: Obsidian points submitted for chemical characterization

Appendix D: Descriptive attributes of obsidian projectile points submitted for chemical characterization

Specimen #	Type	Lentgh	Width	Thickness	Shape	Basal Edge Shape	Notch Type	Blade length	Haft Length	Blade Width	Neck Width	Base Width	SBC	Provenience
LA 635 80.30.237	Cosgrove	10.8	8.4	2.5	triangular	straight	side	7.38	3.2	7.5	4.8	8.4	1.5	Galaz
LA 635 80.30.238	Mimbres	14.6	11.6	2.9	triangular	convex	corner	10.9	4.8	11.6	4.8	11.5	1.8	Galaz
LA 635 80.30.239								21.3						Galaz
LA 635 80.30.240	Cosgrove	21.4		3.6	triangular	straight	side	17.8	3.5	10.1	6.6		2.1	Galaz
LA 635 80.30.241	Cosgrove		9	4	triangular	straight	side		3.8	8.4	5.4	9	2.4	Galaz
LA 635 80.30.243	Cosgrove	19.9	8.2	2.4	triangular	convex	side	14.1	4.7	7.2	5.1	8.2	1.2	Galaz
LA 635 80.30.244														Galaz
LA 635 80.30.245														Galaz
LA 635 80.30.246														Galaz
LA 635 80.30.247														Galaz
LA 635 80.30.248														Galaz
LA 635 80.30.249														Galaz
LA 635 80.30.250														Galaz
LA 635 80.30.251	Swarts	19.6	9.2	3.4	triangular	convex	side	4.1	4.6	7.5	6.2	9.2	2.5	Galaz
LA 635 80.30.252														Galaz
LA 635 80.30.253								19.6			4.6			Galaz
LA 635 80.30.254	A3		8.5	2.8	triangular	straight	corner		3.5	8.5	5.4	5.8	2.2	Galaz
LA 635 80.30.255								17.8						Galaz
LA 635 80.30.256														Galaz
LA 635 80.30.257	A3							16.3						Galaz
LA 635 80.30.258	Mimbres	24.4	10.3	2.2	triangular	straight	corner	20.4	3.9	9.9	5.8	10.3	1.6	Galaz
LA 635 80.30.259														Galaz
LA 635 80.30.260								20.6		11.4	4.1			Galaz
LA 635 80.30.261	A2 / A3	15.4	10.7	3.7	stemmed	notched	basal / side	12.3	3.9	10.6	7.6	8.3	4.5	Galaz
LA 635 80.30.262														Galaz
LA 635 80.30.273	Cosgrove	22.4	8.9	2.6	triangular	straight	side	17.6	4.9	7.8	5.7	8.9	1.6	Galaz
LA 12076 80.30.335														Poe
LA 12076 80.30.336	Swarts	18.1	10.4	3.1	triangular	convex	side	13.1	5.2	8.1	5.2	10.4	1.2	Poe
LA 12076 80.30.337														Poe
LA 12076 80.30.338	A3 / Swarts	20.7	10.8	3.6	triangular	straight	side	6.3	5.4	10.6	7.5	10.8	2.7	Poe
LA 12076 80.30.340	Hinton	24.9	10.2	3.5	triangular	notched	basal / side	20.8	3.9	7.8	6.5	10.2	2.8	Poe
Z:5:10 80.30.772	Hinton	22.4	12.6	2.5	triangular	notched	basal / side	16	6.6	10.6	6.1	12.1	1.2	Z:5:10 (Disert)
Z:5:86 80.30.776	Hinton	23.5	11.4	4.2	triangular	notched	basal / side	17.4	6.4	9.6	6	11.4	2	Z:5:86
Z:13:16 80.30.763	D4	29.4	22.3	6.5	stemmed	straight	side	23.1	9.9	22.3	15.1	14.6	10.1	Z:13:16
Z:13:21 80.30.779	A2	17.4	12.2	3.3	stemmed	straight	side	14.4	5.5	12.2	5	6	4.3	Z:13:21

Appendix D: descriptive attributes of obsidian projectile points submitted for chamical characterization. Materials acquired via institutional loan are presented, for descriptions of obsidian points recovered from Old Town refer to Appendix A. All measurements are in mm.

Appendix D: Descriptive attributes of obsidian projectile points submitted for chemical characterization

Specimen #	Type	Lentgh	Width	Thickness	Shape	Basal Edge Shape	Notch Type	Blade length	Haft Length	Blade Width	Neck Width	Base Width	SBC	Provenience
LA 676 80.30.786	Hinton	28.6	9.5	4.7	triangular	notched	basal / side	19.7	8.3	7.1	5	9.5	3.7	Mattocks
LA 676 80.30.794	Cosgrove	25.6	10.5	3.2	triangular	convex	side	20.9	4.9	10.5	7.1	10.3	1.7	Mattocks
LA 676 80.30.752	Cosgrove	40.4	10	4.1	triangular	straight	side	33.7	6.7	9.5	7.1	10	2.4	Mattocks
LA 635 80.30.230					triangular		corner	31.4		11.9				Galaz
LA 635 80.30.231	Cosgrove	22.9	10.1	4.3	triangular	straight	side	17.9	4.1	9.6	7.4	10.1	1.1	Galaz
LA 635 80.30.232	Cosgrove	22.1	13.7	4.5	triangular	straight	side	16.9	4.6	11.3	8.7	13.7	1.9	Galaz
LA 635 80.30.233	Swarts	14.6	12.1	3.4	triangular	straight	side	10.8	3.9	9.6	6.8	12.1	1.3	Galaz
LA 635 80.30.234														Galaz
LA 635 80.30.235	A3	13.8	7.3	2.6	triangular	straight	side	9.8	2.7	7.2	5.1	7.3	2.5	Galaz
LA 635 80.30.236	Cosgrove	19.4	9.6	3.1	triangular	straight	side	15.4	3.1	7.6	5.5	9.6	2.2	Galaz
25-11-10 95067.2														Swarts
25-11-10 95067.3	preform?	27.6	15.8	6.8	triangular	convex	N/A	25.7	6.8	15.3	15.3	15.8		Swarts
25-11-10 95067.4	Cosgrove						side							Swarts
25-11-10 95067.5	A1		14.7	3.4	triangular	straight	N/A		6.7	14.7	14.7	14.7		Swarts
25-11-10 95067.13	Swarts	23.2	10	2.7	triangular	straight	side	17.9	5.5	8.5	5.2	10	1.2	Swarts
25-11-10 95075	A3	15.3	8.5	2.6	triangular	convex	side	11.9	4.5	7.7	4.9	4.9	1.1	Swarts
29-20-10 97546	Swarts	26.5	11.7	4.4	triangular	straight	side	21.9	4.7	10.6	7.4	11.7	2.6	Swarts
25-11-10 95067.1														Swarts
25-11-10 95068.3	Swarts	19.3	12.1	3.6	triangular	straight	side	15.4	4.6	11.2	8.1	11.1	2.5	Swarts
25-11-10 95068.5								19.9		11.6	6.1			Swarts
25-11-10 95068.6	Cosgrove	20	8.7	2.8	triangular	convex	side	15.8	4.6	8.3	5.1	8.7	1.9	Swarts
25-11-10 95068.7	Cosgrove	18.6	9.8	2.9	triangular	straight	side	14.5	4.5	8.5	6.4	9.8	2.4	Swarts
25-11-10 95068.8														Swarts
26-7-10 95675.2	A5							20.5		12.7	4.7			Swarts
27-11-10 96388.3	Cosgrove			5.1	triangular		side		4.6		6.9		2.7	Swarts
25-11-10 95068.2														Swarts
25-11-10 95068.4	Cosgrove		12.9	3.9	triangular	convex	side		4.1	10.4	7.4	12.9	1.8	Swarts
25-11-10 95068.9	Swarts		10.7	2.8	triangular	straight	side		4.1	8.3	6.6	10.7	1.7	Swarts
25-11-10 95068.10	Swarts	28.3	9.8	3.9	triangular	straight	side	22.5	5.5	7	5.9	9.8	2	Swarts
25-11-10 95068.11														Swarts
25-11-10 95068.12	Swarts	17.3	8.6	2.8	triangular	straight	side	13.4	4.2	7.7	5.9	8.6	2.3	Swarts
27-11-10 96388.1														Swarts
27-11-10 96388.2														Swarts
27-11-10 96388.4	A1 / A3	23.1	10.5	4.1	triangular	straight	N/A	23.1	5.9	10.5	10.5	10.5		Swarts

Appendix D: descriptive attributes of obsidian projectile points submitted for chamical characterization. Materials acquired via institutional loan are presented, for descriptions of obsidian points recovered from Old Town refer to Appendix A. All measurements are in mm.