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An Analysis of Ground Stone from the Basketmaker Communities Project in Montezuma County, Southwest Colorado

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AN ANALYSIS OF GROUND STONE
FROM THE BASKETMAKER COMMUNITIES PROJECT
IN MONTEZUMA COUNTY, SOUTHWEST COLORADO

by

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In this thesis, I analyze an assemblage of ground stone tools, including manos and metates, from Basketmaker III period (A.D. 500-725) settlements in the central Mesa Verde region of Montezuma County, Colorado. Ground stone is a historically understudied class of artifacts, and the data collection and analysis practices employed for most projects remain subpar, despite the publication of best practices guidelines (Adams 2014). Ground stone informs on critical research topics and must be analyzed to the same degree as other artifact categories. The sites include the Dillard site (5MT10647), an aggregated site with a great kiva, and five surrounding, smaller habitation sites termed hamlets. The Basketmaker Communities Project, conducted by The Crow Canyon Archaeological Center, synthesized comparable data from contemporary sites in the region, asking questions about social dynamics at the earliest period of agricultural, sedentary lifeways in this region.

Through the ground stone analysis, I gain insight to the production, use, maintenance and discard of ground stone tools and use the differences and similarities between the Dillard site and the hamlets to discern social dynamics at sites of different scales at the period when lifeways were drastically changing for Ancestral Pueblo people

in the central Mesa Verde region. The results show that residents of the Dillard site ground in longer, intensive sessions, as indicated by their preference for formal tools and their investment in the use lives of those tools. While individual households ground some of their own product, not every household contained grinding tools. Combined with the presence of a mealing pit room that is closely associated with the great kiva, this indicates that at least some grinding took place above the household level at the Dillard site. Ground stone tools from the hamlets were less formal than those at the Dillard site, and while less comfortable in long grinding sessions, required less time to manufacture and maintain. Because of the smaller population at the hamlet sites, grinding tasks had to be completed in shorter sessions to allow time for other household tasks. The higher grinding efficiency of tools at the hamlets reflect the need to maximize ground product processed in each session.

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INTRODUCTION AND BACKGROUND

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Ground Stone as a Historically Understudied Artifact Class

Archaeological research on the Ancestral Puebloans of the American southwest has been conducted for well over a century, leading to immense archaeological knowledge. Despite this extensive research, archaeologists' biases have at times influenced research questions and data collection standards negatively, resulting in knowledge gaps. Ground stone artifacts, including manos and metates, have often been ignored by archaeologists, who have not understood their importance or data potential. This disinterest in ground stone results in an incomplete understanding of the Pueblo past that excludes women's labor and food production, which is the basis for all other aspects of life.

Frequently, ground stone tools are not collected, or sometimes not even recorded, and documentation may be incomplete by excluding artifact counts and providing vague descriptions. Such records also stymie future analysis. Some records consist of only photographs without metadata or archival records (Heitman 2017). Some institutions have discarded or misplaced ground stone artifacts from their collections over time, making the objects unavailable for further study. Ground stone data collection and curation processes have varied widely, but in most cases are insufficient compared to those for other artifact classes. Exacerbating these problems is the fact that ground stone consists of large, stone artifacts that are inconvenient to ship to another location for analysis and costly to curate. Interested researchers must then acquire funding to travel to the objects. This combination of factors inhibits further research which would remedy the lack of scholarly concern and attention.

Ground stone tools have been understudied because of their supposed inability to aid archaeologists in answering questions about the past. But because ground stone has been historically understudied, standard analytical methods have not become widely adopted. Jenny L. Adams's book *Ground Stone Analysis: A Technological Approach* (2014) outlines high quality data collection methods and analytical questions, but in practice, ground stone analysis is not standardized within archaeology to the same degree as other types of artifacts. Ground stone tools do, in fact, contain a wealth of information related to preeminent research topics in the field, including subsistence practices, population dynamics, the organization of labor, and gendered practices. In addition to the broader research topics, ground stone can inform on women's labor, production of important goods, social and political capital, economic contributions, and religious contributions (Heitman 2017). Comparing ground stone tools throughout time and across space can additionally inform on changing foodways.

Archaeology as a discipline of study should strive to utilize all available evidence to answer questions about the past, including ground stone. There have been advocates for the increased study of ground stone almost as long as archaeological research has been conducted in the southwest, as evidenced when Katherine Bartlett inquired:

> Is it not strange that the corn mills of the ancient Southwesterners have received so little attention or thought? In a corn culture such as the Pueblos had, where their very life depended on their crops, what was the most important thing in their homes, if not their grinding stones? Without them their corn would have been of little use [Bartlett 1933:3].

Bartlett also encourages archaeologists not to think of manos and metates as “specimens”, but as incredibly important tools, used for a critical task that sustained populations, and to keep in mind the “real human people like ourselves” whose lives we are attempting to understand (1933:27).

Ground Stone and Gender

Due to countless historic and modern ethnographic comparisons, ground stone tools, namely manos and metates, have been established as Pueblo women’s tools. Wilshusen and Perry (2012) cite ethnographic sources stating that the gendered association was so strong that, historically, at the Rio Grande Pueblos as well as Zuni, men were not even allowed inside granaries. While corn is planted by men, the responsibility is transferred to women after the harvest, when women husk, shell, dry, process, and store the corn, typically working in groups. In addition to corn processing and grinding, most other food preparation tasks are primarily done by women, for domestic and large-scale consumption.

Because manos and metates have been definitively identified as women's tools, their omission from much archaeological research has "obscured—or at times even omitted—women from archaeological interpretations […] through a selective process of archaeological curation and sampling biases" (Heitman, 2017:138). Though women spent innumerable hours of their lives strenuously laboring to feed their communities, as evidenced in their bone morphologies, stress markers, and pathologies (Crown, 2000), the artifacts that inform us of their labor are sometimes viewed as unimportant. Additionally, when the dominant paradigm prioritizes archaeological research of male activities such as flaked stone-tool making and hunting, women's work is further overlooked. Not explicitly considering gender when studying the past "can only serve to reinforce present gender stereotypes" and is objectionable, especially when that research is to "carry the cachet of 'scientific' explanations" (Milledge Nelson, 2004:11).

Though the cumbersome size of ground stone is often cited as the main deterrent to their collection and analysis, ground stone tools may also be passed over for detailed analyses because they are seen as a mundane artifact, without symbolic or ritual significance. However, "[p]reparation of corn meal is a ritual activity that underlies all Pueblo life" and ground stone tools, representing this activity in the archaeological record, cannot be classified as domestic artifacts in opposition to sacred artifacts (Heitman 2016:484). Prayer meal is a term used indiscriminately to mean both corn pollen and corn meal by historic Pueblo informants. There is additionally evidence that pollen-covered maize kernels were ground together and ingested, further blurring the line between spirituality and subsistence (Geib and Heitman 2015). Wilshusen and Perry emphasize that, though ground stone tools were necessary to process the bulk of foods consumed by Ancestral Puebloans, both for domestic consumption and larger-scale feasts, that “corn grinding is also an activity performed intensively by young Pueblo women during female initiation rites—a practice that ties the conception and construction of femaleness to the physical act of grinding” (2012:188).

Additionally, although women are not typically participants in Pueblo religious rituals, “they are central to the ideological basis of this religion. This centrality is underscored by the fact that much of the ritual behavior of the men is imitative of the reproductive power of the women” (Young 1987:436 in Heitman 2016:477). Marlon Magdalena, an artist, educator, and performer from the Pueblo of Jemez, describes how a modern Jemez ceremony incorporates the symbolism of the mano and metate:

> Corn grinding played a large role at all Pueblos. It provided the people with a processed form of corn that we could then use as an offering for ceremonies and as a source for making different types of food. The fall harvest was the time to grind the corn that was grown throughout the summer, and to celebrate in the form of dancing. Manos and metates were originally used to grind the corn. The women would grind the corn, accompanied by singing men and the beating drum. There are certain dances that celebrate the act of grinding corn. In Jemez, we have the Hopi Harvest Dance, where a row of about 20 dancers dance in a row and three to five drummers dance alongside them. After the first song is over, the

> drummers kneel down in front of the dancers, in a position similar to how a woman would […] when she is about to grind corn. Instead of having large, heavy grinding stones carried into the plaza for this particular harvest dance, we use a rasp, with a deer leg bone and gourd, to replace the grinding stone. The drummers place the rasp on top of the gourd and scraped the hard bone across the teeth of the rasp to make a loud […] sound, which […] is meant to sound like the grinding of corn. Harvest time is what this and other dances celebrate [2019, personal communication].

Figure 1.1. Gourd, Rasp, and Deer Bone used in The Jemez Hopi Harvest Dance to Imitate the Sound of Women Grinding Corn (Photograph courtesy of Marlon Magdalena, used with permission).

Women's grinding labor, therefore, should not be considered simply a profane or "economic act but also a liturgical act […] that enables religious practice" (Heitman 2016:479). Women and the groups they ground in likely gained respect and power through their production of physically and spiritually nourishing substances. Fowles asks "who is to say that food preparation—in this case, corn grinding—is any more basic than prayers or dances? […] Surely it is unacceptable to immediately locate corn grinding in the profane simply because it was a female practice" (2013:175-176 in Heitman 2016:474). Ground stone analysis is a meaningful and necessary archaeological practice if we are to understand both Ancestral Pueblo subsistence and spirituality, and to ensure that our interpretations of Ancestral Pueblo culture do not value one gender's labor and social power over another's.

Gender and Ground Stone in the Basketmaker III Central Mesa Verde Region

The Basketmaker III period (A.D. 500-725) in the Central Mesa Verde Region is considered to be a Neolithic Revolution (Kohler, et al. 2008). While it may only be left to speculation whether one gender was primarily responsible for the associated cultural adaptations, women almost certainly played a large role. Wilshusen and Perry argue that while "the emergence of large-scale agricultural production and the concept of the North American Neolithic" are imperative research topics, "it is important to recognize that these changes had profound implications for the role of women in society in general, and the quality and experience of women's daily lives in particular" (2012:188). Thus, a robust study of the Basketmaker III period includes a consideration of women's changing domestic tasks and their roles in managing the time necessary to complete those tasks.

Wilshusen and Perry also argue that the distinct, gendered divisions in food production illustrated in ethnographic accounts took shape in this early period of agricultural intensification. As dependence on maize agriculture and sedentism increased, there were also an increased variety of household duties, which would have necessarily been divided among adults in a household, arguably along gender lines. Archaeologists, however, have traditionally considered men's tasks as more critical or worthy of study, as well as being more socially integrative and public, while women were confined to the home. When women ground together in groups, new cultural ideas may have been formed and transmitted in a similar way to men gathering in kivas. Grinding was also not domestic in the sense of being restricted to the home and often took place in public settings. Crown argues that there was a "clear sexual division of labor but that the two groups of tasks were seen as necessary, complementary, interdependent, and equally valued" (2000:32). Archaeologists must be cautious, therefore, not to impose our own assumptions on gendered tasks and their value in the Basketmaker III period.

The Basketmaker III Period (A.D. 500-725)

In 1939, Earl Morris described the Basketmaker III period as "by far the most important of the entire series" referring to the Pecos classification periods (Wilshusen 1999:166). Though there was Basketmaker III research and literature published at the time of Wilshusen's chapter in the 1999 regional archaeological synthesis of the southwestern Colorado River Basin, he lamented that there was little synthesis and that the period was not integrated with understandings of the preceding or following periods. To address the disjointed research of the period, The Crow Canyon Archaeological Center (Crow Canyon) proposed the Basketmaker Communities Project, the origin of the data used in this study. When the project proposal was submitted in 2011, archaeological interpretations of the Basketmaker III period were still founded on research by T. Mitchell Prudden, Richard Wetherill, and the Basketmaker concept proposed by George Pepper in 1902. There were no Basketmaker III villages or aggregated sites known in the Colorado portion of the San Juan region, making the project a unique opportunity.

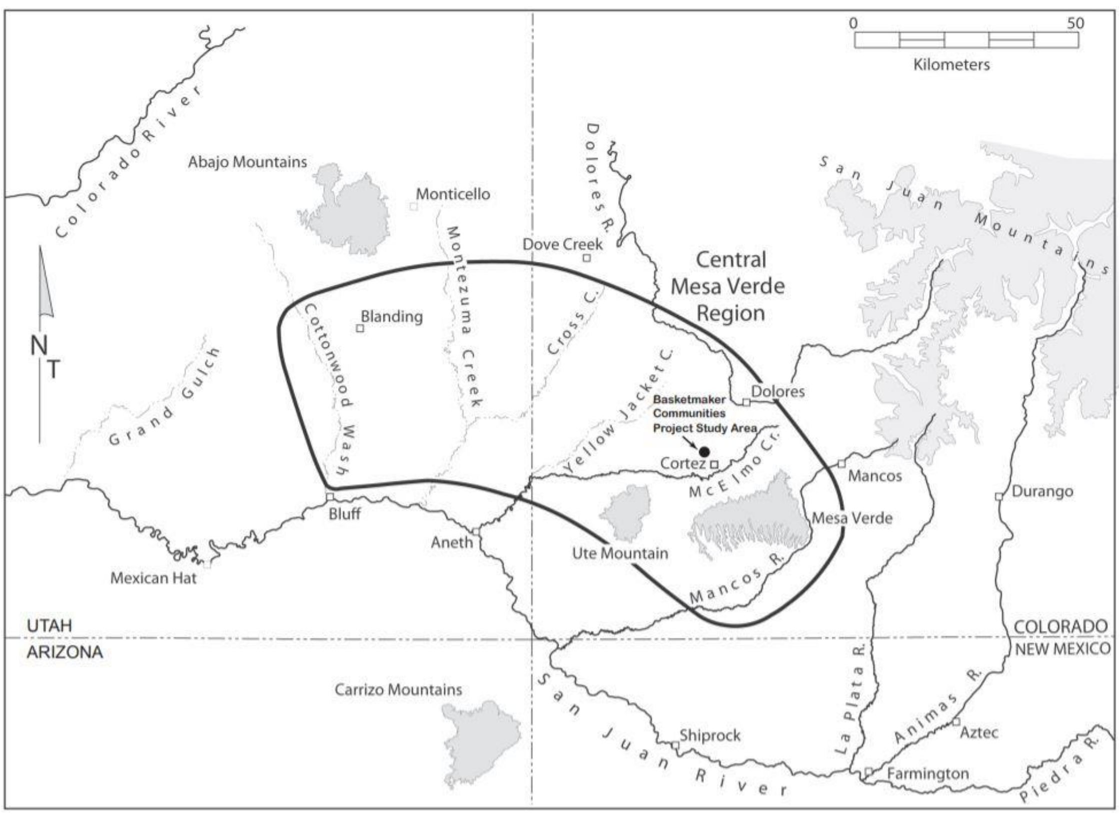


Figure 1.2. The Basketmaker Communities Project Study Area in the Central Mesa Verde Region (Diederichs and Copeland 2012, Fig. 1, used with permission).

Basketmaker III Population Growth and the Neolithic Transition

During the Basketmaker II period (500 B.C. to A.D. 500), there was a distinct decline in population in the central Mesa Verde region between A.D. 375-575, leading to an archaeologically undetectable level of population (The Crow Canyon Archaeological Center 2014, Wilshusen 1999). Areas directly to the east (Durango) and west (Cedar Mesa) were occupied, though the populations had different material culture and likely spoke different languages (Wilshusen 1999, The Crow Canyon Archaeological Center 2014). Maize was first introduced to the Mesa Verde region between 2000-500 B.C. and became prevalent between 300 B.C. (western Basketmaker II) and A.D. 300 (eastern Basketmaker II) (Wilshusen and Perry 2012). The central Mesa Verde Basketmaker III population underwent a Neolithic transition, adopting “a sedentary agricultural lifestyle” (Diederichs 2016:19). Basketmaker II populations grew corn and squash while maintaining residential mobility, hunted with atlatls and darts and had baskets but no cooking pottery. By Basketmaker III, populations grew significantly, and committed to sedentary, farming lifestyles. This period saw the advent of grayware cooking pottery, as well as the adoption of flour maize varieties, beans, and the bow and arrow.

There are conflicting opinions about Basketmaker II avoidance of the central Mesa Verde area. Lipe (1999) attributes the circumvention to economic reasons, with the drastic changes of Basketmaker III increasing both population and dependence on agriculture, necessitating the occupation expansion and facilitating the social integration seen in the emergence of aggregated sites like the Dillard site. Diederichs argues that “socio-political pull factors such as emerging social institutions and increased ceremonialism during Basketmaker III" likely caused the social buffer keeping the area unpopulated to break down, resulting in population expansion (2016:82). The farming potential of the area would have been a draw before Basketmaker III, she argues, and it was for social reasons, not economic, that Mesa Verde region Basketmaker II populations avoided the land between the highly populated areas. In either scenario, or a combination of the two, Basketmaker III community formation and social organization are preeminent research areas.

Basketmaker III settlements are quite varied, though most are one- or two-household habitations. Architecture is dominated by semi-subterranean pithouses without contiguous surface structures as seen in later periods. Storage, particularly of food, became a considerable concern with increased reliance on agricultural products and commitment to sedentism. Though corn, beans and squash were all regularly consumed, weedy annuals that invaded fields such as "pigweed, goosefoot, sunflower, beeplant, and lambsquarter" as well as wild plants like ricegrass, pinyon, opuntia and wolfberry also comprised a significant portion of the Basketmaker III diet (Wilshusen 1999:186, Geib 2019, personal communication). This is important to bear in mind during ground stone analysis, as maize was not the only plant processed with grinding tools. Seasonal fruits, nuts and berries may also have been processed with ground stone tools before consumption. The increased reliance on plant foods was matched by a decreased consumption of hunted meat, though semi-domesticated turkeys were still a critical source of protein (Wilshusen 1999).

Pitstructures from the Basketmaker III period are highly variable in construction, though more labor was invested in their construction during this era than before, another indication of increased sedentism (Lipe 1999). Although great kivas are known to the Basketmaker III period in the Four Corners region, none had been identified in southwest Colorado before the Basketmaker Communities Project. Lipe suggests:

> "[t]he presence of a great kiva may be an indicator of increased organization at the community or locality level. Group rituals and other assemblies held in such structures could have reinforced whatever institutions were involved in conflict resolution or other organizational tasks at the suprakin level," [Lipe 1999:424].

Diederichs further asserts that in addition to great kivas, oversized pithouses and "rock art panels depicting processions to circular center places all provide evidence of likely periodic gatherings of 100 to 400 people" (2016:23).

Despite the significance of the social networks required to coordinate gatherings of that size, Diederichs contends that the Dillard site should be considered an aggregated site rather than a village, because "household architecture is built independently at aggregated sites rather than being incorporated into contiguous architectural units" and it also did not have a permanent population of over 100 people, which is considered to be the minimum for a village (2016:106). The significance of the great kiva and temporary housing at the Dillard site should not be underestimated, however; during the Pueblo I period (A.D. 750-900), great kivas were present but not at every community, with oversized pitstructures more common (Schachner, et al. 2012, Lipe 1999). Aggregated sites like the Dillard site are some of the earliest examples of Pueblo social institutions and their architectural representations that follow. “The dramatic and transformative choices made during the Basketmaker III period (A.D. 500-750) set in motion eight hundred years of Pueblo occupation in the San Juan Frontier” (Diederichs 2016:44).

Environment

The project area is in the eastern portion of the central Mesa Verde region, within the McElmo drainage unit (Diederichs and Copeland 2012). The McElmo Creek drainage is characterized by many small and medium canyons, with only ephemeral water flow, apart from the Dolores River canyon in the northeast of the unit (Adams and Petersen 1999). The sites included in this study are situated north of a creek, “on a dissected upland between Alkali Canyon to the west and the less-substantial Crow Canyon to the east” (Diederichs and Copeland 2012:1). Soils overlying the Dakota sandstone consist of eolian silt and sand blown in from further south in the San Juan Basin, often reaching as far east as Durango. These loamy soils are relatively agriculturally productive.

At canyon heads throughout the region, including nearby Alkali Canyon, where weathered sandstone and shale deposits are in contact, “the permeable layers form a high-quality aquifer that gives rise to numerous springs” (Diederichs and Copeland 2012:3). Alkali Canyon additionally exposes 100 million years of geological formations, from late Triassic and Jurassic through Middle Cretaceous. These formations provide a variety of lithic raw materials used by Ancestral Puebloans for stone tool production, including the majority of materials used to make ground stone tools.

The present-day Indian Camp Ranch includes farm fields and ranch lands, with the latter primarily in a Sagebrush-Saltbush biotic community, dominated by big sagebrush, rabbitbrush, and bunch grasses. Prehistorically, the ranch was covered by pinyon pine and Utah juniper woodlands, and included yucca, prickly pear cactus, and bunch grasses. Fauna local to the McElmo drainage unit included small mammals and coyote (*Canis latrans*), with few large ungulates, "though antelope (*Antilocapra*) and (formerly) the desert bighorn (*Ovis*) likely were found here" (Adams and Petersen 1999). Artiodactyls were identified during faunal analysis at the Dillard site; most of their bones had been modified and turned into tools (Sommer, et al. 2017a). Remains of a domestic turkey (*Meleagris gallopavo*), possibly sacrificed, were found in the antechamber of a pithouse at Mueller Little House (5MT10631; Sommer, et al. 2017a).

The average elevation of the project area is 1890 m (6200 ft). The Koppen classification system identifies the region as a "cold, middle latitude, semiarid climate, in which potential atmospheric evaporation regularly exceeds the amounts of precipitation available" (Adams and Petersen 1999). Between 100 B.C. and A.D. 600, there was a regional cold period (Diederichs 2016). Precipitation consists of snow in winter and sporadic, intense thunderstorms between July and September. The area receives "relatively consistent summer growing-season precipitation that ranges between 158 and 244 mm, increasing with altitude" and the average annual precipitation is 13.12 in (Wilshusen, et al. 2012:15). Though growing crops at higher and therefore wetter altitudes "and in water-rich river valleys generally increases the risk of early and late summer frost," farmers can mitigate this by "selecting upland field areas with favorable aspects and lower risk of cold air drainage" (Wilshusen, et al. 2012:15). Locations below 6000 ft receive more frost-free days, "but require management of runoff or irrigation to get enough water to the immature maize plants" (Diederichs 2016:16). Mastery of these agricultural techniques has led to successful farming despite the inherent risks.

Basketmaker Communities Project Background

The Crow Canyon Archaeological Center

The Crow Canyon Archaeological Center (Crow Canyon) is a 501(c)(3) not-for-profit archaeological research and education organization located in Cortez, Colorado. They conduct world-class archaeological research through local field work and in-house laboratory analysis. They have educational and experiential field and lab programs for youth and adult participants, whose participations provide the bulk of the labor for their research projects. Crow Canyon also has a Pueblo Advisory Group who consults on all aspects of their research, programs, and curriculum. Crow Canyon practices what it has termed responsible archaeology or the conservation method. This is achieved through precise sampling to answer specific research questions rather than excavating large portions of a site. Representative sample excavations are able to provide rich insight while minimizing the extent of excavations. Additionally, their manuals and reports are publicly available online.

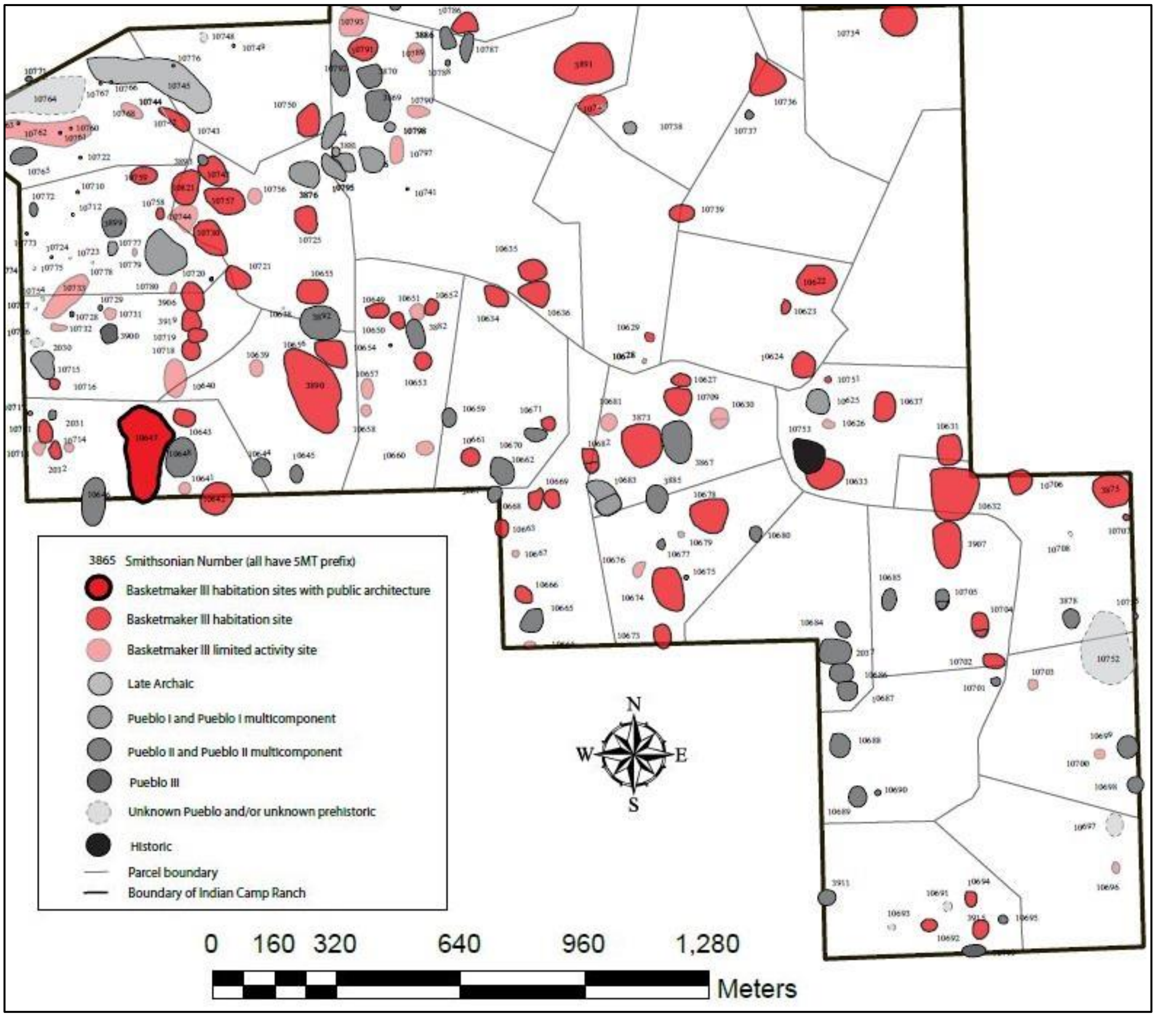


Figure 1.3. Map of Indian Camp Ranch with Known Archaeological Sites (Diederichs and Copeland 2012, Fig. 2, used with permission).

Indian Camp Ranch

The Basketmaker Communities Project was conducted at Indian Camp Ranch, a 1200-acre private housing subdivision located two miles west of Cortez. Land parcels are "sold to private citizens who are required by deed restrictions to protect the archaeological resources on their property" and all "work must be done under the guidance of an approved archaeologist who properly reports on all work, findings, and results" (Ortman, et al. 2011:1). Homeowners are not obligated to permit archaeological work, however, and can additionally create their own research stipulations, for example, only permitting surface mapping or remote sensing or limiting the extent of excavations (Diederichs and Copeland 2012).

There are 208 known archaeological sites at Indian Camp Ranch, 107 of which date to or have a component dating to Basketmaker III, with an overall high site density of about one site per four hectares (Diederichs and Copeland 2012). There are many other known Basketmaker III sites in the vicinity, including 37 recorded during a hazardous fuels reduction project immediately south of Indian Camp Ranch, and six located on Crow Canyon's campus (Ortman, et al. 2011). The Basketmaker III sites in Indian Camp Ranch occupy an area of over 800 ha between Alkali and Crow Canyons. This area, like the Montezuma Valley in general, has few Pueblo I components or sites; most of which are concentrated on a ridge in the center of Indian Camp Ranch (Woods Canyon Archaeological Consultants, ca. 1991).

Uniquely, "the majority of these pithouses have not been obscured by later Ancestral Pueblo sites or modern buildings. Together, these sites possibly comprise the most extensive and best-preserved cluster of Basketmaker III remains in the northern San Juan region" (Ortman, et al. 2011:2). In 2012, the Indian Camp Ranch Archaeological District was listed on the National Register of Historic Places and the Colorado State Register of Historic Places, with the Basketmaker III sites contributing to its eligibility (Diederichs and Copeland 2013).

Basketmaker Communities Project Research Design and Questions

The Basketmaker Communities Project focused on the “important but underinvestigated” period from A.D. 500-750 (Diederichs and Copeland 2012:1). The project was designed to answer questions related to broad regional topics, such as “when and why the northern San Juan was homesteaded in the A.D. 600s” and the “nature of social organization during this period” (Ortman, et al. 2011:4). In particular, the Village Ecodynamics Project guided many of the research questions, and focused on estimating maximum momentary population for the region (See Varien et al. 2007). The concept of the Neolithic Demographic Transition additionally guided the research design, as the project was designed to provide information on settlement patterns and social institutions as populations transitioned to full-time sedentary agriculture in the northern southwest (Ortman, et al. 2011:1).

Ortman and others (2011) argue that the Basketmaker II populations to the west of the project area were immigrant farmers from southern Arizona who had arrived in the area by 400 B.C., while the eastern Basketmaker II populations were Indigenous foragers who were committed to agriculture only by the first centuries A.D. The proposal authors additionally assert that “by the mid-A.D. 800s there is evidence that Pueblo I period villages were organized around sodalities with governing functions like those of historic Pueblos,” which calls into question whether the beginnings of these institutions were in place during Basketmaker III or if they formed in Pueblo I (Ortman, et al. 2011:10-11).

The social organization and institutions of the Basketmaker III period were additionally of interest because commitment to sedentism creates vastly different social dynamics than mobile lifestyles. "Unlike mobile foragers, sedentary people cannot avoid most social problems simply by moving away. As such, social integration can be viewed as the way that conflict is avoided in sedentary societies through cooperation and communication" (Ortman, et al. 2011:13). The Dillard site, with integrative architecture such as the great kiva and temporary housing for visitors, likely played an important role in this social integration. Through ceremonies and other social rites, the larger community congregated and created cohesion between previously disparate peoples. Understanding its relationship to its neighboring sites is considered to be "essential to our understandings of how early Pueblo communities formed and were organized" (Diederichs and Copeland 2012:1).

Ortman and others assert that, in addition to the unique research opportunity at the Dillard site and the surrounding Basketmaker III site cluster, the Basketmaker Communities Project also provides the chance to synthesize the Basketmaker III archaeological record for the area (2011). The project was designed to sample many sites within a close range of each other, gather analogous data and allow for comparison between sites and a better understanding of their relationships to one another. The conservation method was used, ensuring that excavation units were carefully targeted such that similar excavations took place at all sites. While the same methods were employed in the Dillard site excavations, the site is dramatically larger and has different types of architecture than the others, resulting in a larger amount of excavation.

Site Descriptions

Six Basketmaker III habitation sites comprise the sample for this study (Table 1.2). These sites were chosen from the Basketmaker Communities Project sample due to the comparability of their data based on similar sampling strategies, as well as the presence of typologically identifiable ground stone artifacts at each site; sites that had only bulk indeterminate ground stone (BIG) were excluded. Several Pueblo II sites were also excavated as part of the project but had extensive recent disturbance that required different sampling methods than the Basketmaker III sites, leading to much smaller artifact assemblages (Sommer, et al. 2017a). These sites were excluded due to incomparability. Diederichs created the structure type and functional categories used in the Basketmaker Communities Project. Table 1.1 describes each type that is present in the sample sites. Table 1.2 lists all the sampled structures and nonstructures at each site. Double-chambered structures are only counted once, although each chamber was assigned a unique structure number by Crow Canyon.

Structure Type	Details	Main Chamber Diameter	Floor Area	Depth	Functional Category
Great Kiva	Roofed communal architecture	>10m	>80m^2	>0.5m	Public Architecture
Oversized Pithouse	Massive permanent pithouses with domestic features and extra storage	>7m	>130m^2	>1m	Permanent Housing
Large Shallow Double-Chambered Pithouse	Seasonal Pithouse	>5m	>30m^2	>0.5m	Temporary Housing
Large Single-Chambered Pithouse	Early Basketmaker III Pithouse	>5m	>20m^2	>0.5m	Permanent Housing

Large Shallow Single-Chambered Pithouse	Seasonal Pithouse	>5m	>20m^2	>0.5m	Temporary Housing
Double-Chambered Pithouse	Common year round Pithouse	<7m	15-50m^2	>0.5m	Permanent Housing
Single-Chambered Pithouse	Year-round Pithouse	2.3-4.6m	6-20m^2	0.6-1.3m	Permanent Housing
Pit Room	Milling, processing, etc.	<3m	<6m	0.2-0.7m	Specialized Use

Table 1.1. Basketmaker III Structure Types Represented in the Study Sites (Adapted from Diederichs 2016:111-112).

Site No., Name	Dates	Structures (STR)	Non-structures (NST)
5MT2032, Switchback	A.D. 650-725 (Late BMIII)	Double-Chambered Pithouse 110, Pit Room 113 **(Count: 2)**	Midden 101, Mixed Deposit 102, Midden 115 **(Count: 3)**
5MT10631, Mueller Little House	A.D. 660-690 (Late BMIII)	Double-Chambered Pithouse 101-102-114 **(Count: 1)**	Mixed Midden Deposit 104, Extramural Use Surface 110 **(Count: 2)**
5MT10709, Portulaca Point	A.D. 575-660 (Mid BMIII)	Double-Chambered Pithouse 106-111, Pit Room 115 **(Count: 2)**	Midden 101, Midden 105 **(Count: 2)**
5MT10711, Ridgeline	A.D. 660-725 (Late BMIII)	Oversized Pithouse 101-103, Pit Room 110, Pit Room 116, Pit Room 117 **(Count: 4)**	Midden 106, Extramural Use Surface 109, Extramural Use Surface 120 **(Count: 3)**
5MT10736, TJ Smith	A.D. 660-750 (Late BMIII, Early PI)	Single-Chambered Pithouse 111, Pit Room 108, Pit Room 109 **(Count: 3)**	Midden 101 **(Count: 1)**
5MT10647, Dillard	A.D. 620-725 (Mid BMIII, Late BMIII)	Great Kiva 102, Pit Room 124, Double-Chambered Pithouse 205-226, Double-Chambered Pithouse 220-234, Double-Chambered Pithouse 236, Single-Chambered Pithouse 231, Single-Chambered Pithouse 232, Single-Chambered Pithouse 239, Pit Room 228, Double-	Storage Pit 101, Artifact Scatter 108, Artifact Scatter 109, Midden 203, Midden 213, Extramural Use Surface 216, Midden 302, Midden 318, Extramural Use Surface 304, Artifact Scatter 403, Artifact Scatter 502 **(Count: 11)**

		Chambered Pithouse 309, Double-Chambered Pithouse 311, Double-Chambered Pithouse 312-324, Single-Chambered Pithouse 313, Pit Room 330, Pit Room 331, Pit Room 332, Pit Room 333, Double-Chambered Pithouse 505-508 **(Count: 18)**	

Table 1.2. Site Dates, Structure Numbers and Nonstructure Numbers at The Sample Sites.

The Switchback Site (5MT2032)

The Switchback site (Figure 1.4) was a habitation dating from A.D. 650-725. The site was located on the east side of a ridge, 250 m northwest of the Dillard site within a cluster of four sites, of which Switchback and Ridgeline (5MT10711) were selected for sampling (Diederichs, et al. 2014). Structure 110 was the main chamber of a double-chambered pithouse and contained a hearth, a full domestic assemblage on its floor and an intact corner storage bin. Structure 113 was selected for sampling from an L-shaped alignment of nine slab-lined storage rooms. The structure contained raw clay, suggesting the space was used for pottery production. There was abundant grass pollen on the floor, either from a grass-thatch roof or harvesting or processing grass grains.

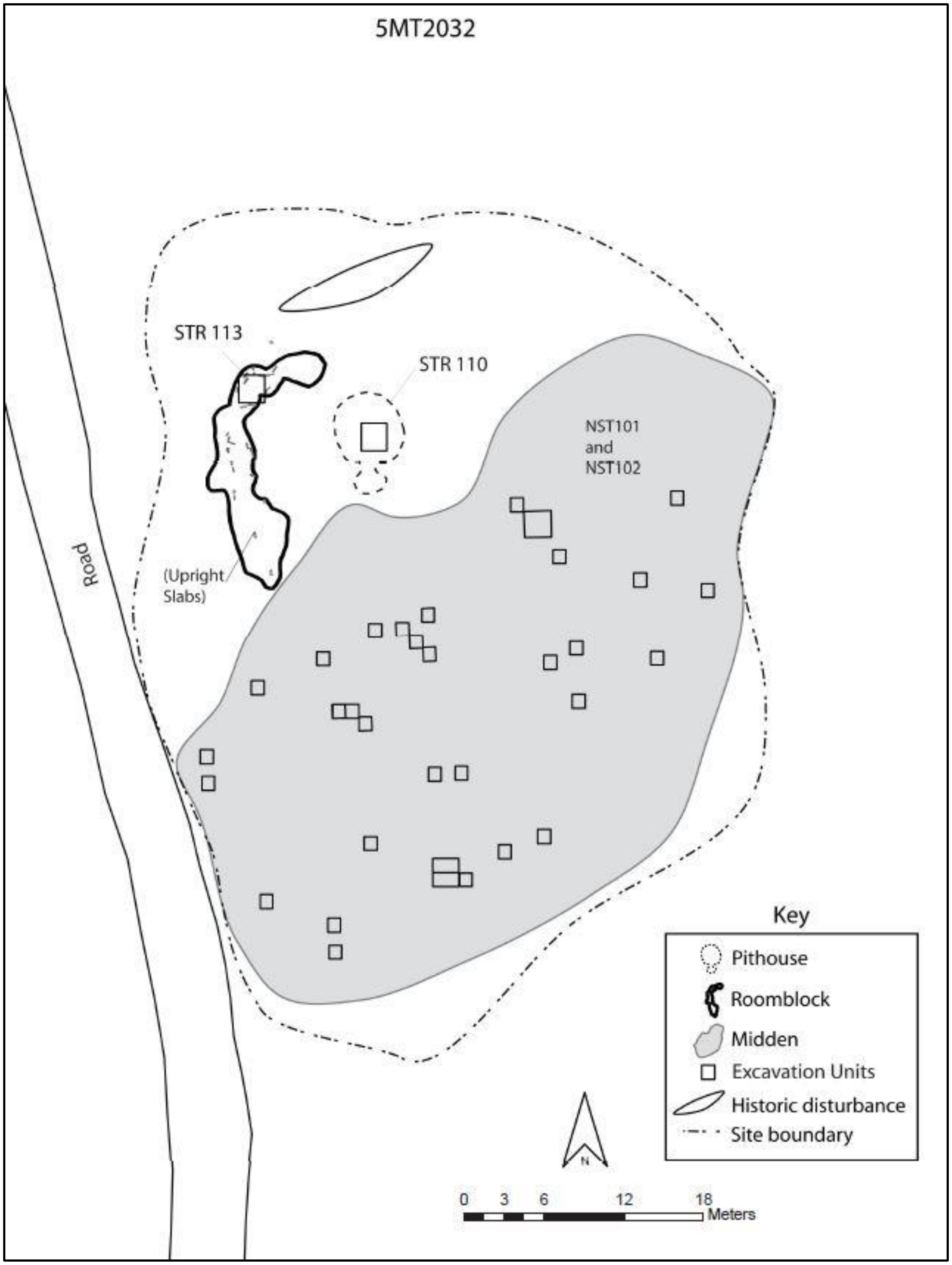


Figure 1.4. Site Map of 5MT2032, The Switchback Site (Sommer, et al. 2014, Fig. 3, used with permission).

The large trash midden contained a high artifact density. An additional midden lay east of structure 110 with upright slabs visible on the surface that were likely part of a checkdam (Sommer, et al. 2015). Pollen analysis indicated moderate use of both maize and native plants, including beeweed, carrot family, possible grasses, cheno-ams, juniper and sagebrush (Sommer, et al. 2016). Faunal analysis indicated that lagomorphs were the dominant taxa and that complete animals were brought to the site for processing and consumption (Sommer, et al. 2017a).

Mueller Little House (5MT10631)

Mueller Little House (Figure 1.5) was a habitation on the north end of a low ridge in the eastern portion of Indian Camp Ranch, dating A.D. 660-690. Structure 101-102-104 was a pithouse with a main chamber, antechamber, and side room connected to the main chamber. The main chamber contained a hearth, floor vault and a complete floor assemblage. The antechamber notably contained a nearly complete turkey, which was possibly sacrificed (Sommer, et al. 2017a:9). There was evidence of a doorway between the main and antechambers, and of a ramp between the main chamber and side room. The structure represented at least two major construction events and burned during its decommissioning. A disturbed, mixed midden deposit occurred southeast of the pitstructure, along with an extramural use surface with two postholes, possibly indicating a ramada over the work area (Sommer, et al. 2017a).

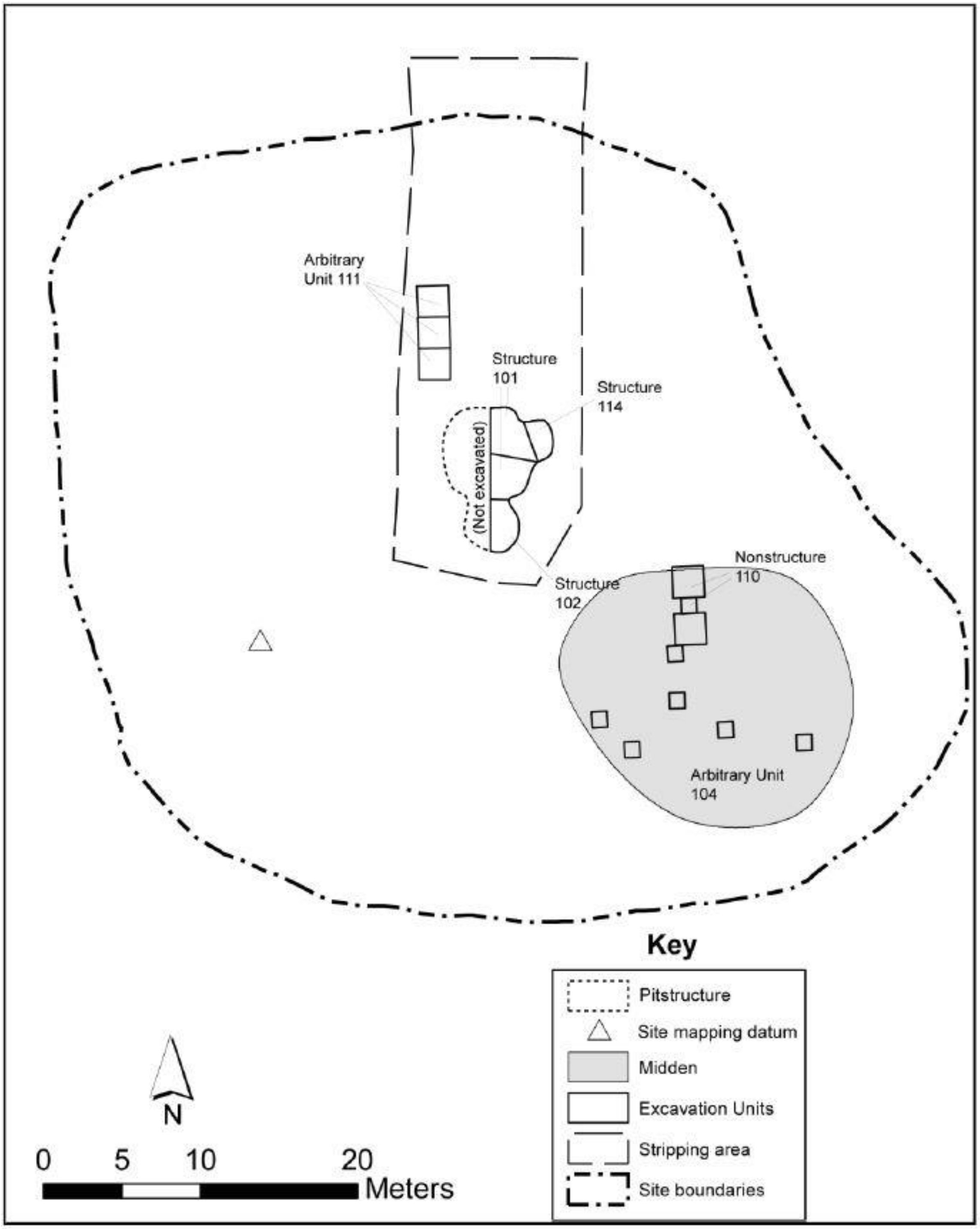


Figure 1.5. Site Map of 5MT10631, Mueller Little House (Sommer, et al. 2017a, Fig. 12, used with permission).

Portulaca Point (5MT10709)

Portulaca Point (Figure 1.6) was a single habitation dating roughly to the mid-Basketmaker III period, which Crow Canyon defines as A.D. 575-660 (Sommer, et al. 2015). Structure 106-111 was a double chambered pithouse. The main chamber contained a hearth located on bedrock, its only domestic feature, and a complete floor assemblage on the plastered floor, including yellow pigment. Both chambers burned upon decommissioning. Structure 115 was a semi-subterranean slab-lined storage room (Sommer, et al. 2016). Nonstructures 101 and 105 were the east and west middens, respectively. The east midden contained at least one posthole, suggesting a ramada or other shelter, and the west midden contained a possible storage pit (Sommer et al. 2015).

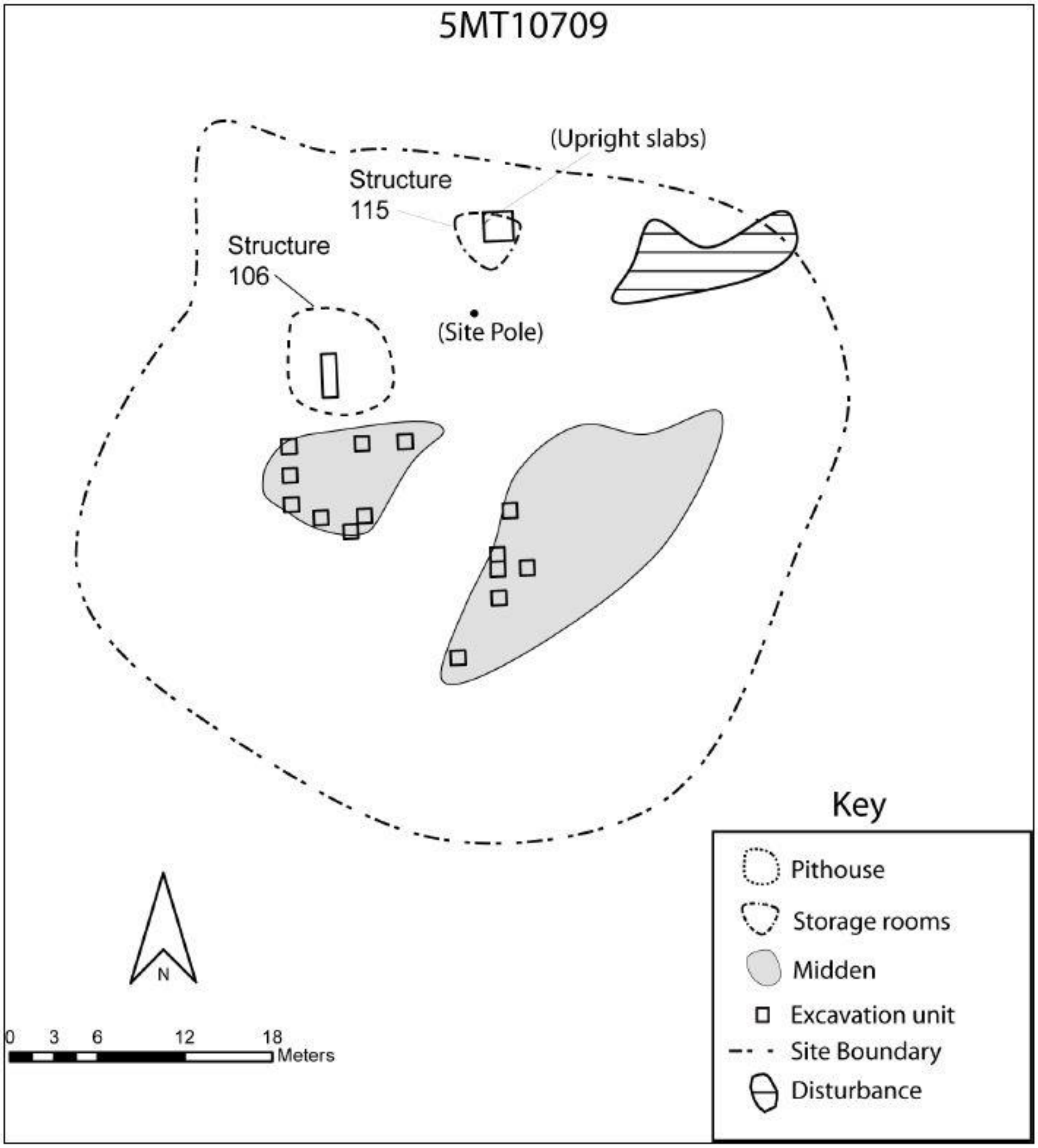


Figure 1.6. Site Map of 5MT10709, Portulaca Point (Sommer, et al. 2016, Fig. 3, used with permission).

The Ridgeline Site (5MT10711)

The Ridgeline site (Figure 1.7) was a habitation on the westernmost ridge of Indian Camp Ranch, dating to the late Basketmaker III period (A.D. 660-725; Sommer, et al. 2017a). It had the most pitstructures of any site in the sample besides the Dillard site. Pithouse 101-103 was a double-chambered, oversized pithouse. The main chamber had a hearth, and a complete floor assemblage, as well as evidence for at least two remodeling events. The earliest floor had two sipapus and two postholes, suggesting a smaller pitstructure that was subsumed by the construction of the pithouse. Notable artifacts included beads, red and yellow pigments, a plaited sandal, and an elk or large mule deer antler with red pigment on it. The antechamber also had a hearth, and evidence for at least one remodeling event.

Pit Room 110 did not have a hearth or any floor artifacts and remained unburned. Pit Room 116 did not have a hearth, either, but contained pendant blanks, suggesting a specialized use of that room, though no ground stone was found there (Sommer, et al. 2017b). Pit Room 117 was a shallow, post and slab-lined room containing an enclosed adobe bin. This room also had a specialized function, having no hearth, but four broken vessels and raw clay, suggesting pottery production. Nonstructure 106 was a low-density midden with modern disturbance. Nonstructures 109 was an extramural surface containing a turquoise pendant. Nonstructure 120 was located below 109 and had two pit features but no artifacts.

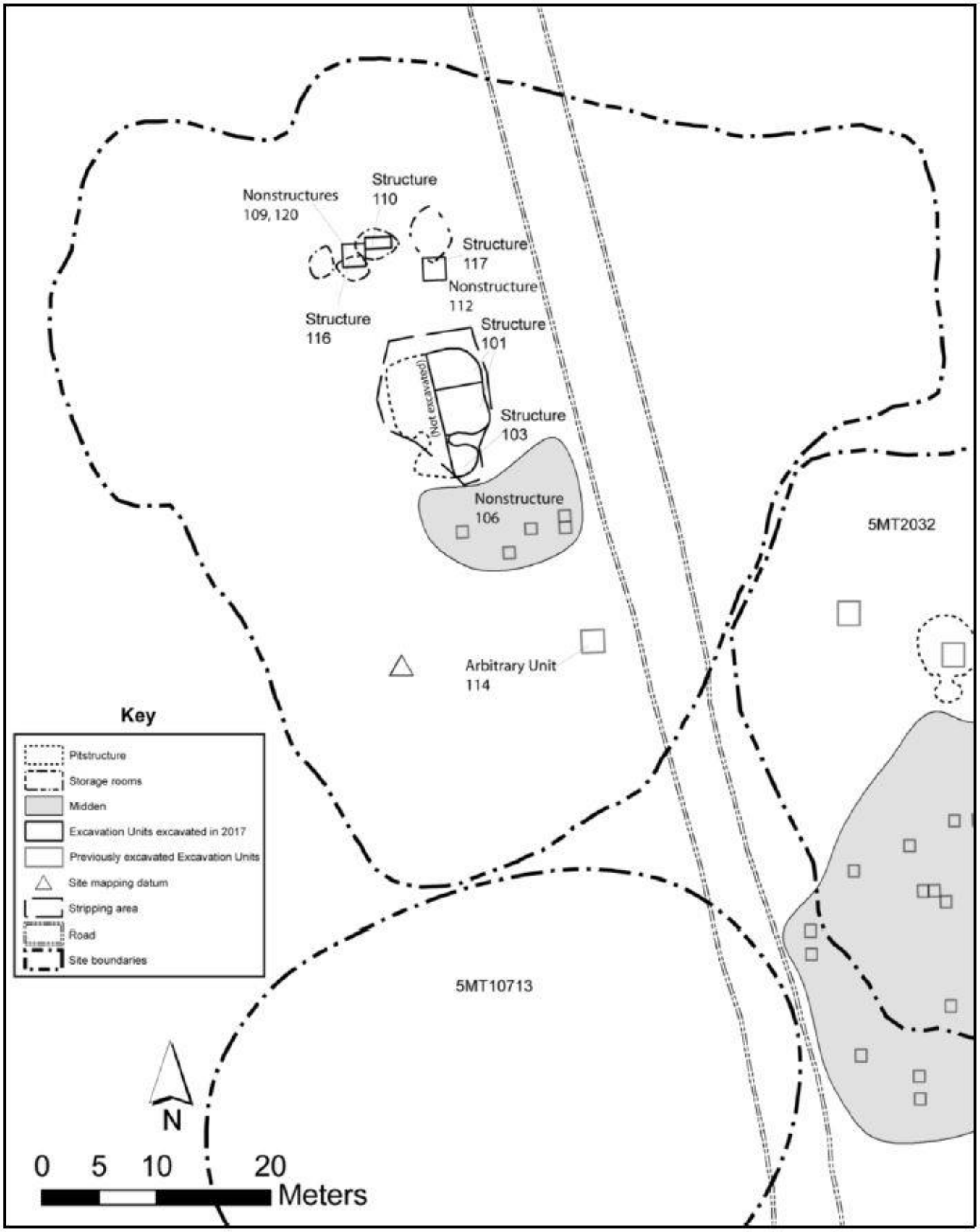


Figure 1.7. Site Map of 5MT10711, The Ridgeline Site (Sommer, et al. 2017b, Fig. 3, used with permission).

The TJ Smith Site (5MT10736)

The TJ Smith site (Figure 1.8) is a habitation located in the northeast edge of Indian Camp Ranch, dating to late Basketmaker III, possibly into Pueblo I, approximately A.D. 660-750 (Diederichs, et al. 2014). Pithouse 111 was a large, single-chambered pithouse that contained a hearth, sipapu, and basin-shaped pit, but no domestic assemblage; it burned during decommissioning. Pit rooms 108 and 109 were "contiguous, small, above-ground storage rooms directly south of the main chamber of the pithouse" (Diederichs, et al. 2014:21). Pit room 108 was circular and was likely roofed, while pit room 109 was rectangular and lined with upright stone slabs. They predate pithouse 111. Arbitrary Unit 101 was a thick midden southwest of the pithouse. Pollen analysis indicated "an emphasis on three probable local native resources: nightshade family, carrot family and tansy mustard" (Sommer, et al. 2015:11). Pithouse 111 contained primarily native pollens, while pit room 108 contained "abundant maize pollen", suggesting it was used "for processing and possibly for storage of harvests" (Sommer, et al. 2015:11).

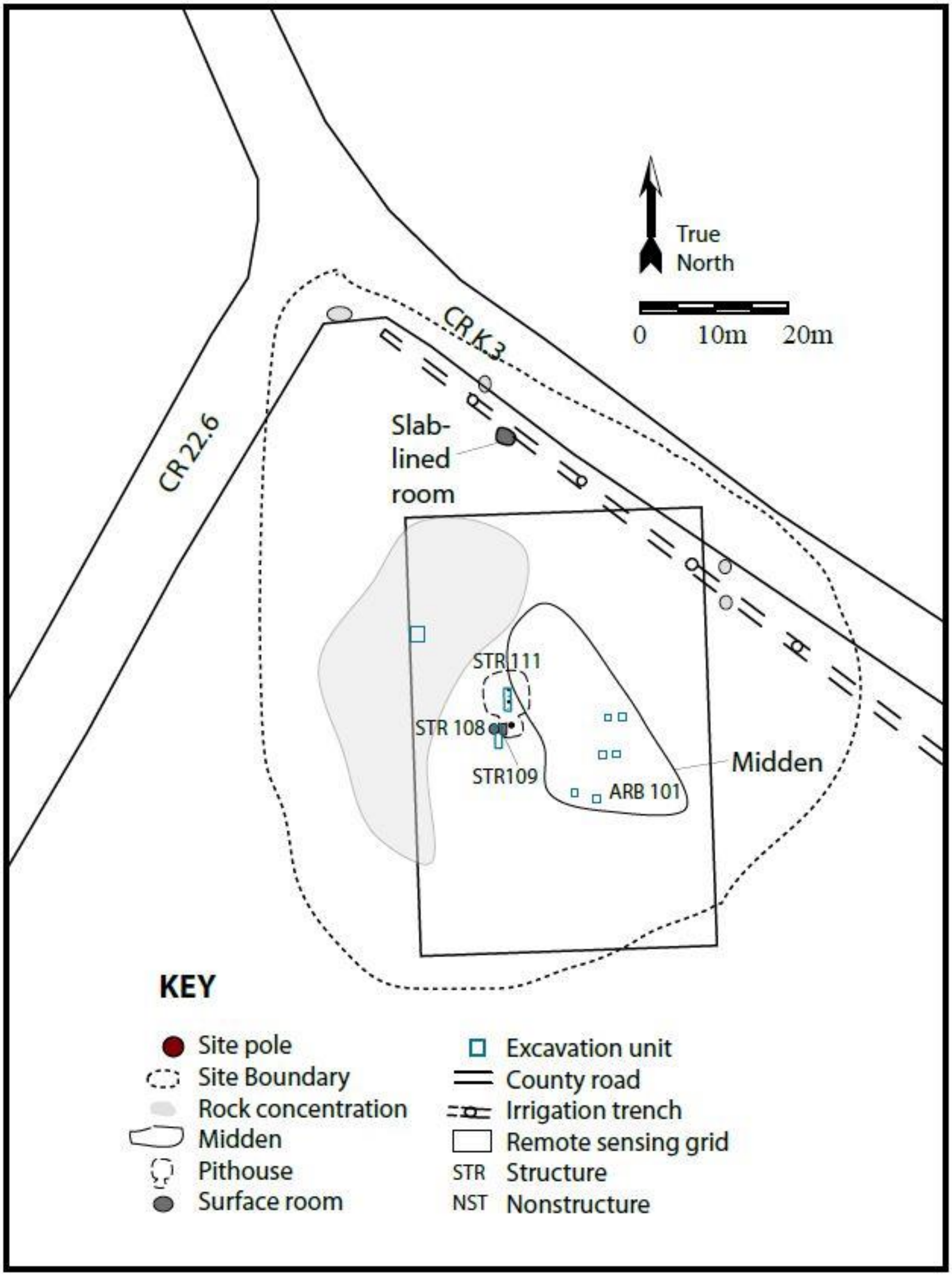


Figure 1.8. Site Map of 5MT10736 (The TJ Smith Site) (Diederichs, et al. 2014, Fig. 27, used with permission).

The Dillard Site (5MT10647)

The Dillard site (Figure 1.9) was an aggregated community, dating A.D. 620-725 (Mid-Late BMIII), whose earliest occupation predated that of the smaller, neighboring hamlet sites. The site was larger than anticipated during previous surveys and was divided into five architectural blocks. Architectural blocks 100 and 200 were divided somewhat arbitrarily in terms of space, however, block 100 contained public architecture and block 200 was a residential block, comparable to block 300, located on the opposite side of the great kiva. Blocks 400 and 500 were, again, somewhat arbitrarily divided, and located on the northwest edge of the site, apart from the larger, central residential blocks.

The great kiva (structure 102) was in use from A.D. 625-725 (Diederichs and Copeland 2012). It was constructed of large, coursed masonry, with a five-course masonry wall encircling the kiva. There were four layers of sequential floor surfaces. The earliest two had unique combinations of sipapus, floor vaults, and pits. The third floor was sand and ash with microlithics and broken serving bowls. The fourth and final floor burned. No true hearth was located, though a shallow firepit was found where a hearth would be expected based on the alignment of floor features (Diederichs and Copeland 2012). Earlier floor features are oriented northwest to southeast, and later features had a north to south alignment. This switch in feature orientation happened in structures across the site. Structure 124 was a small pit room without a hearth or floor assemblage, though a large piece of raw turquoise was present in a pit feature. Nonstructure 104 was a large storage pit north of the great kiva full of secondary refuse. Nonstructures 108 and 109 were sparse, 15x15m artifact scatters southeast of the great kiva.

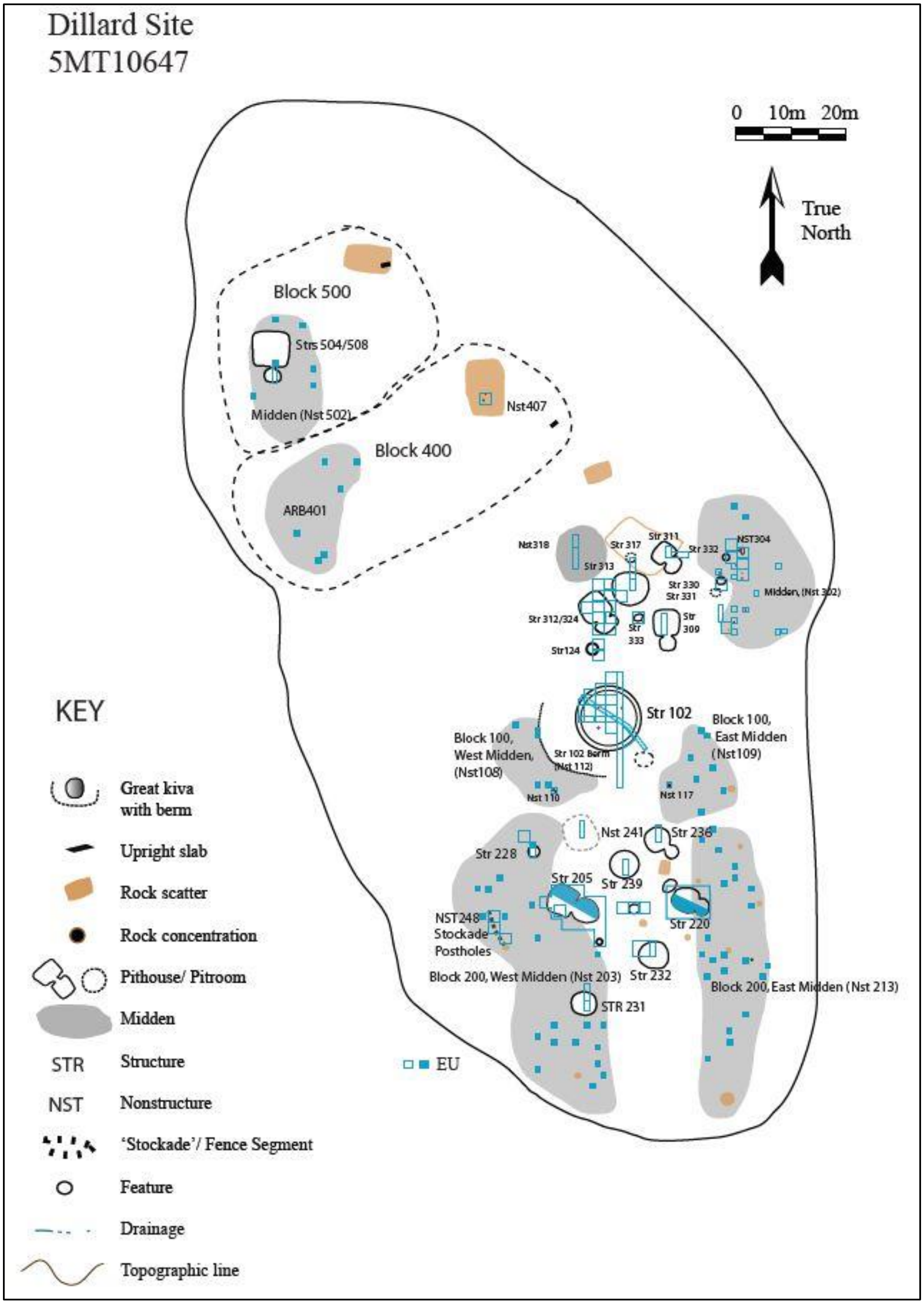


Figure 1.9. Site Map of 5MT10647, The Dillard Site with Excavation Units in Blue (Diederichs, et al. 2014, Fig. 16, used with permission.)

Architectural blocks 200 and 300 contained the bulk of the structures at the site and were comparable in number to each other. Double-chambered pithouse 205-226 had domestic features, including hearths, in both the main and antechambers and was burned. The pithouse was oriented northwest to southeast, perhaps indicating contemporaneity with the earlier great kiva construction events. The antechamber contained the only stone mortar in the project assemblage. The main chamber of pithouse 220-234 (Figure 1.10) had upright slab storage bins and a “full milling assemblage” (Diederichs, et al. 2014:16). This included a metate left on three sandstone supports, and “[t]he position of the metate would have caused the ground materials to fall directly into a pit feature located in the floor surface” (Sommer, et al. 2015:23). The room was likely used for food production, particularly considering that the ample storage space left little room for other activities.

Figure 1.10. Structure 220 Floor Assemblage, Facing South. Note Metate on Sandstone Blocks in Center (Sommer, et al. 2015, used with permission).

Structure 236 was the main chamber of a double-chambered pithouse, the antechamber of which was not tested. The structure had a hearth but no floor assemblage and burned lightly upon decommissioning (Diederichs, et al. 2014). Structure 231 was a single-chambered pithouse used for permanent housing, which had a hearth but no floor assemblage. Structure 232 was a single-chambered pitstructure used as temporary housing and possibly for ritual activities (Diederichs and Copeland 2013). Structure 239 was a single-chambered pitstructure used as temporary housing. Structure 228 was a small, shallow mealing and storage room associated with Structure 205-226. A broken mano and metate fragment on the floor indicate the food processing activities that took place in the room and the presence of a hearth suggests that this pit room may have been extensively used, perhaps as an extra living space (Diederichs and Copeland 2012).

Nonstructure 203 was a 56 x 16 m midden on the west slope of the ridge, which likely served four to six houses, including structures 205-226 and 228. Nonstructure 213 was a 53 x 13 m midden on the east slope of the ridge, probably serving two to four houses including structure 220. Nonstructure 216 was an extramural work surface found in conjunction with sediment stripping to delineate pithouse 205-226 boundaries and included turquoise and other minerals and pigments (Diederichs and Copeland 2012).

Architectural block 300 also contained several pitstructures, pit rooms and middens. Structure 309 was the main chamber of a double-chambered pithouse, the antechamber of which was not tested. It had a hearth but no floor assemblage and was burned. Structure 311 was also the main chamber of a double-chambered pithouse with an untested antechamber. It contained a hearth, sipapu and an additional pit feature but was cleared of its floor assemblage and lightly burned during decommission. Structures 312 and 324 were the main and antechambers of a large, shallow, seasonally-used pithouse. The main chamber had a hearth and storage features while the antechamber had no domestic features but both chambers contained complete floor assemblages (Diederichs and Copeland 2013).

Pit rooms 330, 331 and 332 were storage rooms with no floor assemblages that remained unburned. Pit room 333 was a small, post-frame pit room without a hearth, floor assemblage, or evidence of burning (Sommer, et al. 2015). Nonstructure 302 was a 20 x 28 m midden located downslope to the east of the pithouse (Diederichs and Copeland 2013). Nonstructure 318 was also a midden but was originally identified as an unknown geophysical anomaly and was therefore tested with trenches instead of 1 x 1 m sample units, so its dimensions are unknown. Nonstructure 304 was an extramural surface with five pit features, including a possible roasting pit, a posthole, one possible storage pit and one large storage pit lined with upright slabs (Diederichs, et al. 2014).

Architectural block 400 contained nonstructure 403, which was initially thought to be a midden but was a light scatter of artifacts upon testing (Diederichs and Copeland 2013). Architectural block 500 contained double-chambered pithouse 505-508. The sample units did not reveal a hearth in the “robust” main chamber, though a pit feature was found (Diederichs, et al. 2014:20). The antechamber was a shallow, slab-lined room also containing a pit feature, which “might have functioned as a metate bin or above floor storage bin” (Diederichs, et al. 2014:29). Though root and animal disturbance made interpretation difficult, the presence of a two-hand mano in the antechamber supports the metate bin interpretation.

Radiocarbon and archaeomagnetic samples returned several dates for the Dillard site. Burned corn and juniper seeds from structure 220 “were radiocarbon dated and yielded two sigma dates of cal A.D. 610 to 670 and cal A.D. 620 to 670 (p=0.95)” (Diederichs and Copeland 2013:12). The hearth collars from structures 228, 226, 236, and 232, as well as the charred floor of structure 101 returned archaeomagnetic dates that were roughly contemporaneous, in the early to mid-seventh century A.D. (Sommer, et al. 2015). The majority of samples returned dates in the mid-A.D. 600s, meaning “[t]he pitstructures and great kiva on the Dillard site predate the other farmsteads within Indian Camp Ranch” for which the dates cluster in the late-A.D. 600s into the early A.D. 700s (Sommer, et al. 2015:29). The great kiva was in use later than the pithouses were occupied, into the early-A.D. 700s, and it is likely that the surrounding farmsteads continued to use it even as the houses at the Dillard site were no longer occupied.

Maize and native resources were both moderately used at the Dillard site. Macrobotanical samples included maize “in nearly every context sampled”, though in overall low amounts (Diederichs, et al. 2014:24, Sommer, et al. 2015:11). Squash, goosefoot, and pigweed were also widely present. The great kiva had a wider variety of plant materials and included the highest presence of cheno-ams. This is likely due to use of a “broader spectrum of subsistence resources and/or different cultural activities” (Sommer, et al. 2015:11). Structure 220 which was probably used for food processing or storage had maize, rose family, and prickly pear pollen. Both structure 220 and the great kiva had high levels of juniper and sagebrush, perhaps from roofing, fuel wood, or burning that took place during the closing of the structure.

Structure 205 samples revealed birch and cattail, both water indicators, but no maize pollen. The bin feature in the structure contained the only cholla from the project, which suggests cholla processing in the structure, and implies collecting trips or trade connections since cholla is rare in the area (Sommer, et al. 2015). Tansy mustard and wild tobacco pollen were both found in structure 228. Phytolith analysis indicated "the presence of maize, cucurbits, and sedges; no evidence of beans was noted", though maize cob phytoliths were relatively low, possibly from poor preservation (Sommer, et al. 2015:13). Faunal analysis indicated that, as at other sites in the study, lagomorphs were the dominant taxa and were brought back to the site for processing and consumption. At architectural block 300, jackrabbits outnumbered cottontail, but the opposite was true for block 200. Artiodactyls were almost solely found in architectural block 200, and the majority were made into tools (Sommer, et al. 2016).

Petrographic analysis additionally indicated that at least four different pottery compositions were present at the Dillard site. This could be due to "different communities of practice, or production groups, residing at the settlement, each group having learned pottery production techniques in distinctive ways," due to trade, or experiments with clays and tempers by the emigrants that lived at the Dillard site (Sommer, et al. 2015:12). Overall, there is evidence for both permanent and temporary habitations, food storage and processing and "possibly communal cooking" (Diederichs, et al. 2014:25). Given this, the Dillard site should be interpreted as a "permanent home of families organized into neighborhoods and a central gathering place for a larger community" (Diederichs, et al. 2014:25).

CHAPTER TWO

METHODS

Adams's Theoretical Approach to Ground Stone Analysis

Methods for this study broadly follow Crow Canyon's standard procedures as outlined in their lab manual (Ortman et al. 2005), as the Basketmaker Communities Project was designed and implemented following them. However, the more detailed ground stone analysis procedures (Appendix A) were developed specifically for the Basketmaker Communities Project, based on the methods and theory outlined in Jenny L. Adams's *Ground Stone Analysis: A Technological Approach* (2014). Adams is widely considered to be an expert on ground stone analysis and her theoretical approach has significantly improved the way archaeologists conceptualize categories of ground stone and their attributes.

Adams's definition of ground stone is "any stone item that is primarily manufactured through mechanisms of abrasion, polish, or impaction or is itself used to grind, abrade, polish, or impact" (2014:3). These typological boundaries are constructs created by analysts and ground stone may not have been a conceptual category of objects to the people who created and used them. Additionally, "[f]rom the perspective of the tool user, abrading, smoothing, and polishing are three distinct activities, each requiring a differently textured tool," so what archaeologists refer to as ground stone tools may not have been classified as similar or related (Adams 2014:81).

Adams's approach focuses on the life history of objects and emphasizes "the importance of individuals as social agents who make culturally constituted choices concerning design, use, and disuse" of their technologies (2014:8). Therefore, archaeologists must develop classificatory and analytical systems that are meaningful, while also keeping in mind those social agents who created tools to meet certain needs. This is particularly important to remember with regards to ground stone. Ground stone analysis should focus "on the combination of knowledge, ideas, behavior, and equipment that solves problems of altering surfaces or reducing substances" (Adams, 2014:19).

Design theory asserts that the ways in which objects are designed and manufactured are reflections of informed technological choice by their creators, who accommodate competing demands of the tasks at hand (Adams 2014). An analyst can, therefore, examine an object and interpret quantifiable variables to attempt to reconstruct the constraints that were accounted for in the manufacture of the object. Design is frequently dictated by issues of cost, such as distance to raw material sources or time and skill required for manufacture. "The prioritization of choices reflects the socio-cultural context of the relevant group making the choices" and indicates which aspects were the most important to address for a given tool design (Adams 2014:11). In the U.S. southwest, Adams asserts that ground stone tools were made by the person who intended to use them and were rarely made by a specialist, making design theory particularly applicable (2014).

Because ground stone is frequently analyzed in much less detail than other artifact types, many unfounded speculations continue to circulate amongst archaeologists. For example, early theories about ground stone took an evolutionary perspective, that recognized changes in grinding tool form with the beginning of agriculture. Basin metates were said to be the predominant type, used with one-hand manos to grind wild seeds, until maize became an agricultural staple, when trough metates and two-hand manos surpassed them. This theory is thought to be so unequivocally true that it has not received further confirmation through large-scale studies or experimental archaeology, which, again, is true of ground stone in general.

Adams, however, argues that archaeologists should not simply assume there is a direct and invariable correlation in tool form to the specific foods being processed. She has done a great deal of experimental work, adding weight to her claim. Instead, she posits that "design developments were unrelated to how foods were acquired but were instead sensitive to changes in recipes and the ways foods were processed" (Adams 2014:125). Through experimental work, she has also shown that dried seeds and the flour produced from them store longer than fresh or soaked seeds and the resultant flour. If recipes changed to accommodate this knowledge, then grinding surfaces may in turn have increased in size to accommodate the extra energy required to grind dried seeds.

Despite this, Adams asserts that there are overall patterns in the prevailing metate types over time in the southwest. From A.D. 300-500, ¾ trough and open trough metates were introduced. By A.D. 500, there is evidence that trough metates were widespread. In southwest Colorado and southeast Utah, ¾ trough and Utah trough metates (a ¾ trough metate with a mano rest) were the predominant type. This is particularly interesting to note, because slab metates dominate the assemblage considered in this study. Adams makes these points to argue that "food-grinding technology in particular, and grinding technology in general, varied through time and across space in the U.S. Southwest—a fact that has been underutilized in attempts to understand the dynamics of prehistory" (Adams 2014:131). Archaeologists have assumed that the variation in ground stone technology is minimally important, but the insights gained from ground stone analysis disrupt over-simplified generalizations and strengthen our archaeological interpretations.

Crow Canyon's Protocol

Crow Canyon's lab and field manuals outline their particular theoretical approach to archaeology. Notably, they adhere to Lipe's Conservation Model (see Lipe 1974). This is carried out through qualitative sampling, by excavating specifically placed, small excavation units chosen for their likelihood of answering research questions for the project (Ortman, et al. 2005). This makes high-quality, accurate analysis and curation critically important, in order to encourage research using the collected data without further excavations. As part of this mission, they also facilitate use of their research database by outside researchers, as is the case for this study.

Crow Canyon additionally conducts their research with the assumption that artifacts reveal the behaviors of past peoples in their design, function, and use histories. Despite post-abandonment processes that disturb the original deposition of artifacts, there is utility to middle-range research, and Crow Canyon understands artifact locations in general to be "the result of patterned human behavior" (Ortman, et al. 2005:1-3). Artifact distributions and spatial patterns at archaeological sites are informative and valid sources of knowledge about past behaviors.

Crow Canyon conceptualizes space at archaeological sites in a hierarchical system starting with the site, then designating architectural blocks (which are numbered by 100s), next designating study units and, if applicable features within them. Study units are a “specific structure or area of investigation within a sampling area or architectural block” (The Crow Canyon Archaeological Center, 2001:1). The first type of study unit is structures, or cultural spaces bounded by three or more walls which are typically roofed. Pertinent to this project, pithouse main chambers, antechambers, and any additional attached rooms all get a different study unit number. Excavation units will not be coded as structural until the excavation reaches below the tops of the associated walls. The next type of study unit is nonstructures which are neither bounded by walls nor roofed but have definable boundaries. This includes middens and extramural work areas. Finally, arbitrary units are defined by the archaeologists and are not a culturally bounded space.

Study units are then further divided into segments of horizontal and vertical space, and a provenience designation (PD) is assigned for each. PDs are also assigned to horizontal and vertical segments of features. Each PD in turn will be assigned both a general and specific Fill/Assemblage Position (FAP) as well as a general and specific Fill/Assemblage Type (FAT). FAPs include designations such as cultural surfaces, wall/roof fall, and undisturbed sediments. FATs include types such as cultural, post-abandonment, non-cultural, and mixed deposits. Lastly, point locations (PL) are sometimes assigned to a specific artifact and plot the exact vertical and horizontal location of the object.

Crow Canyon, as one aspect of their multi-faceted mission, is “committed to accomplishing long-term research on a par with the finest archaeological research conducted anywhere in the world” (Ortman, et al. 2005:1-1). Their laboratory procedures reflect this by systematically analyzing artifacts using high-quality methods that match or surpass those used by other research laboratories. These standards produce high-quality data that maintains analytical consistency across multiple projects, which address Crow Canyon’s specific research goals and is useful for outside researchers with different research questions (Ortman, et al. 2005).

Crow Canyon retains a permanent laboratory staff, consisting of a manager, analysts, and educators. However, the majority of artifact processing and analysis is conducted by seasonal interns, trained volunteers (who must commit to a regular schedule), adult program participants, youth participants ranging from elementary through high school age, and both high school and college field schools. This is feasible because laboratory tasks are structured so that simpler tasks, such as washing artifacts, are done first, allowing younger or less experienced participants to complete them. The more complex aspects are saved for the end of the process, and only undertaken by older and more experienced participants. In other words, collections management tasks are completed upfront, and analyses are done later (Ortman, et al. 2005).

Importantly, procedures are carefully structured to minimize the chances of record-keeping errors or loss of provenience control. Steps between the initial sorting of artifacts and data entry are minimized. As an additional precaution, a consistency check is completed only by laboratory staff for each bag of artifacts as they are entered into the database. Though accomplishing high-quality lab work while working with the lay public, including children, provides its own set of challenges, Crow Canyon asserts that "it leads to better-organized, and […] better-documented laboratory procedures," because procedures must be straightforward and streamlined, and all work double checked for errors at each stage of artifact processing (Ortman, et al. 2005:1-2).

Artifact Type Definitions

The artifact typologies used in this study follow the Crow Canyon Laboratory Manual definitions (Ortman et al. 2005), as the artifacts were collected and analyzed using that system. Artifact types are assigned based on the last function of the tool, and previous uses may be noted in the comments. Adams disagrees with this approach, as well as some of the analytical categories. The following table (Table 2.1) is derived from Ortman et al. 2005, and Adams's differing definitions and additional comments are discussed at the end of the section.

Artifact Category	**Description**
Mano	Manos are the active element used to grind substances including seeds (often corn kernels) and minerals against a metate. Function properly with compatible configuration to metate. This category includes manos that cannot be classified as a one- or two-hand because they are broken.
One-Hand Mano	A mano held in one hand and used in a circular grinding motion. Round to oval in plan, oval cross-section. Made from cobbles.

Two-Hand Mano	A mano held in both hands and moved in a back-and-forth motion along the length of a metate. When used with a slab metate, have one to four grinding surfaces; with trough metates, have one to two.
Metate	Metates are the passive element that remains stationary while being used with a mano to grind substances. This category includes metates that cannot be classified as slab, basin, or trough because they are broken.
Slab Metate	A metate with a flat or nearly flat grinding surface that spans the majority of the object's surface. Longitudinal cross-section may be moderately concave but lateral cross-section is flat. Edges are often shaped. Used with two-hand manos.
Basin Metate	A metate with a concave, basin-shaped grinding surface, used with one-hand manos.
Trough Metate	A metate with a trough-shaped grinding area that runs parallel to the length of the stone. Depths vary widely, troughs may be open on one or both ends. Used with two-hand manos.
Pestle	Pestles are handheld grinding tools with long, cylindrical shapes and grinding/battering wear on at least one end. Used to grind/pound substances inside the cavity of a mortar. Made of tough materials.
Stone Mortar	A passive grinding implement with a hollowed-out, steep-sided bowl suitable for use with a pestle. Have pounding/grinding use wear, made of tough, coarse materials.
Abrader	A coarse-textured rock that has one or more grinding surfaces but lacks formal shaping. Usually made of tabular sandstone and fit in one hand. Can be actively or passively used for a variety of purposes.
Polishing Stone	As defined in the Laboratory Manual, a pebble or cobble that was used to polish the surfaces of pottery vessels. The polishing stones in this sample were used to polish floors or walls.
Maul	A stone tool with two blunt ends and a pecked groove or notch at its midsection for hafting parallel to a handle. Usually not polished. Battering on ends. Often made from repurposed axes.
Bulk Indeterminate Ground Stone (BIG)	Fragments of stone that exhibit grinding but are too small to be categorized as a particular type of artifact. Crow Canyon curates these in bags separated by PD and material type.
Pecking Stone	A rock with ridges battered through use, grinding sometimes evident in small areas. Often battered cores. Used to roughen/sharpen manos and metates when they are worn too smooth to effectively grind, possibly used to shape building stones. Lighter percussion activities than hammerstones, resulting damage more uniform/evenly spread.

Table 2.1. Artifact Categories Represented in The Study.

Figure 2.1. Complete One-Hand Mano from The Dillard Site. Note Pecking on Grinding Surface, Edge Shaping for Comfort and Flatness of Surface from Use Wear. (Length 13.7 cm). (The Crow Canyon Archaeological Center, used with permission).

Adams proposes a different categorization of ground stone, based on her extensive experimental and ethnoarchaeological studies. These approaches may be more fine-tuned and produce slightly more precise data. Adams, however, recognizes that "[t]ime constraints usually dictate that choices be made among variables to be recorded," based on project design because "[g]round stone can be cumbersome to analyze," particularly in the high level of detail she outlines in her book (2014:49). Because much of the artifact processing and analysis at Crow Canyon is done by lay participants, and ground stone is often analyzed in the field, their more straightforward, quicker analyses are better suited. Some of Adams's analyses are better suited to those specifically trained in ground stone use-wear analysis and would simply not be possible under the time and personnel constraints at Crow Canyon, due to their public education mission. Adams put it succinctly when she says, "Not all ground stone needs to be analyzed under a microscope, but it is amazing what is missed by not doing so" (2014:49). It is not that one method is correct and the other incorrect, but that one is more detailed than the other.

The theoretical differences between Crow Canyon's and Adams's methods begin with her assertion that "a tool that was secondarily used should be classified according to its original design" (2014:78). This approach aims to understand the initial material choice and design process and to track the modifications (if any) necessary to change or expand the function of the tool. Crow Canyon's last use approach is based on the idea that later uses may partially or completely obscure previous ones, but that analysts may record all uses of the tool in the comments. Both methods specify that if the order of uses cannot be discerned, the most extensive use should dictate the artifact category.

A major point of differentiation is that Adams does not classify manos as one-hand or two-hand; rather, they are identified by their compatible metate type. Adams also classifies metates differently and bases her metate type definitions on the intentional strategies with which they are designed and manufactured, rather than the outcome of the use patterns. Flat/concave metates are what have previously been described as slab metates. Flat/concave manos are typically flatter and longer than other types, though they may include both Crow Canyon's "one-hand" and "two-hand" mano qualities. Manos are still shorter than the metate width, however, and may be used in multi-directional or reciprocal strokes. The cumulative wear results in concave grinding surfaces, with extensive use confining meal in a similar way to a basin metate (Adams 2014:107). Adams emphasizes that this exemplifies why it is important to understand how manos and metates are shaped through use wear, otherwise they may be classified as different types rather than different stages of the same type.

Basin metates have circular or elliptical grinding surfaces in an intentionally created basin. Basin manos are used with a combination of circular and reciprocal grinding strokes, which may obscure evidence of intentional basin manufacture. This may make it difficult to differentiate between shallow basin metates and well-used flat/concave metates. Trough metates have “intentionally manufactured rectangular basins” (Adams 2014:110). Trough manos have only reciprocal grinding strokes due to the physical restrictions of troughs. There is often no distinction between their grinding surfaces and their ends from use in unmaintained trough metates. This happens because, through use wear against the sides of the trough, manos become shorter, and in turn wear on a narrower portion of the trough. Trough metates may be refurbished once worn to maintain the shape of the trough. If they are not, use wear analysis will be necessary to distinguish an unmaintained trough metate from a basin metate (Adams 2014).

Lastly, flat metates remain flat because they are used with manos that are the same length as their grinding surface widths. They may be plastered in bins or used on the ground. Flat manos also remain flat and are additionally more likely to have multiple grinding surfaces than other mano types. A major point of Adams’s research is that, contrary to long and strongly-held assumptions held by archaeologists, “morphology does not indicate what specific food substances are processed" (Adams 2014:104). While there may be specific use patterns at a given site, only through magnified or use wear analysis can we confidently determine whether a two-hand mano was used to process maize, and a one-hand mano used to process wild seeds.

Experimental work on abraders has additionally quantified use wear patterns associated with different material types. While archaeologists have long known that abraders were used to shape bone, shell, stone, other minerals and wood objects, these distinctive use wear patterns may allow the abrader category to be further subdivided. For example, Adams has shown that V-shaped abrader grooves are used to add points to awls and needles and to grind the edge of flaked tools. U-shaped abrader grooves, on the other hand, are "for working slender wooden rods for spinning tools, for awls or other weaving tools, and for prayer sticks" (Adams 2014:87). While these distinctions are beyond the scope of this study, they are important to keep in mind when attempting to understand how Ancestral Puebloans may have conceptualized their own tool categories.

Lithic Raw Material Types

The majority of the lithic material types represented in this sample are locally available to each of the sites. Quartzite and Unknown Silicified Sandstone are non-local materials, while the Dakota, Burro Canyon, and Morrison Formations each have outcrops in nearby canyons, such as Alkali Canyon, that made them readily available to Ancestral Puebloans in the project area. Igneous material outcrops closest to the study area at Ute Mountain in Towaoc, Colorado (roughly 12 km) and the La Plata mountains in Durango, Colorado (roughly 46 km). Sandstone may be found across the landscape and is considered immediately local to the site (Ortman, et al. 2005). The following table (Table 2.2) briefly summarizes the local material types, including those used for peckingstones, which are not used to grind and therefore require different properties. For further information see Ortman et al. 2005.

Material Type	Appearance	Geologic Formation
Agate/Chalcedony	Translucent, white to off-white, lustrous, fine-grained, smooth	Product of the dissolution and precipitation of silica; found in Dakota Sandstone and Burro Canyon Formations.
Dakota/Burro Canyon Silicified Sandstone	Tan, white, or light gray, glistening/ "sugary", medium-grained, slightly rough surfaces, hard/tough	Derived from sand dunes deposited in fluvial environments, with grains cemented by silica then replaced by microcrystalline quartzite; found in Dakota Sandstone and Burro Canyon Formations.
Igneous Rock	Light to dark gray, non-granular with an assortment of crystalline inclusions, rough, varies from hard to friable	Derived from lavas and magmas produced during volcanic activity, excluding obsidian; found in Ute Mountain, La Plata Mountains, Dolores/Mancos Rivers, McElmo Creek.
Morrison Chert	Mottled shades of maroon, green, tan, brown, very fine-grained, smooth but frequent flaws, still excellent flaking qualities	Derived from volcanic ash deposited in shallow lake environments; found in Burro Canyon Formation and Brushy Basin Member of Morrison Formation.
Morrison Mudstone	Mottled shades of maroon, green, tan, brown, gray, moderately smooth, "gritty"	Composed of silicified silt and volcanic ash deposited in a lake environment; found in Burro Canyon Formation and Brushy Basin Member of Morrison Formation.
Morrison Silicified Sandstone	Mottled, muted shades of maroon, green, tan, brown, coarse-grained, hard/tough, not easily flaked	Derived from sedimentary sands deposited in still-water setting, then cemented with silica; found in Brushy Basin Member of Morrison Formation.

Sandstone	Dull, grainy, rough, friable, may be thin and tabular, blocky, or irregularly shaped	Consists of sand grains held together in a matrix of silica; common throughout all local geologic formations.
Slate/Shale	Light to dark gray, smooth, medium- to fine-grained, tabular; Slate hard enough to be polished	Slate is metamorphosed shale, which has been altered by intense heat/pressure; commonly found in Dakota and Mancos Formations; slate occurs only where there has been volcanic activity.

Table 2.2. Lithic Material Types Represented in The Study.

Artifact Variables and Analytic Procedures

Crow Canyon's ground stone analysis form was modeled after Adams's methods, and collects detailed information about ground stone artifacts. Some aspects of Adams's methods have been adjusted to better flow with Crow Canyon's specific laboratory procedures, and some were simplified to enable better data collection given time constraints, as previously discussed. Both Crow Canyon's Laboratory Manual and Adams's Methodology are suited to any ground stone assemblage in the American southwest, though Crow Canyon created their ground stone form specifically for the Basketmaker Communities Project.

Ground stone analysis does require some training and supervision, specifically, the ability to tell manufacturing damage such as flaking and shaping apart from use wear, and to identify direction of grinding stroke. However, using these methods is a straightforward process that does not require a microscope for basic use wear analysis. The analysis form (Appendix A) is designed for in-field use, allowing for thorough data collection without mandating artifact collection, though ground stone may be brought back to the lab for analysis and curation. These methods serve as an example of how to gather high-quality data that lends itself to many research questions without incurring the inconveniences that become excuses for not analyzing ground stone. Table 2.3 outlines the artifact variables and recording methods. Because some ground stone is not curated, a detailed sketch of each use surface of every artifact is drawn, and a photograph taken.

Variable	Description	Values
Condition	Assessing completeness of artifact	Complete: not broken or missing large fragments; Incomplete: broken but original size/shape can be estimated; Fragment: broken and size/shape cannot be estimated
Artifact Type	Assigning the artifact to a functional, interpretive category	See Table 2.1 (above)
Material Type	Identifying the lithic material out of which the tool is made	See Table 2.2 (above)
Granularity	Visually identifying grain size of the lithic material to assess coarseness	Fine <1mm, Medium 1-2mm, Coarse 2-4mm, Conglomerate > 4mm
Increased Coarseness	Assessing whether the artifact surface was pecked or roughened to improve its performance	True or False
Design	Assessing whether the tool was modified beyond basic functionality	Expedient: natural shape altered only through use or to make tool functional; Strategic: possesses modifications that improve tool efficiency, comfort, or aesthetics
Use	Assessing whether the tool was used in one or multiple ways	Single use: used for one function; Multiple use: used for an additional function
Degree of Wear	Assessing the loss of substance from the surface of a tool as a result of grinding (Adams 2014:28)	Light: barely visible with unaided eye; Moderate: damage obvious but has not altered basic shape of tool; Heavy: natural or modified shape of tool has been changed through use
Pigment Present	Assessing the presence of pigment on tool surface using a hand lens	True or False

Striations	Assessing the visibility of striations from grinding on tool surface using a hand lens	Multi-directional; Linear; None Visible
Abrader Grooves	Assessing whether an abrader has grooves on its surface	True or False
Number of Abrader Grooves	Identifying the number of grooves on abrader surfaces	Count
Internal Groove Striations	Assessing the visibility and direction of striations from use within an abrader groove	True or False
Weight	Using a digital scale to weigh the artifact	Recorded to nearest 1/10th g or nearest 1/10th kg for metates
Artifact Dimensions	Measuring maximum dimensions of artifact with digital calipers or measuring tape when size prohibits	Maximum dimensions recorded to nearest 1/10th cm. Length and Width; or Diameter; Thickness
Mano Cross-Section	Assessing linear cross-section of manos as a reflection of use history and wear maintenance	See Table 2.4 (below)
Number of Ground Surfaces	Assessing the number of distinct use surfaces present on the artifact	Numbered from largest/most used to smallest/least used
Dimensions of each Surface	Measuring the maximum dimensions of each use surface exhibiting wear	Maximum dimensions recoded to nearest 1/10th cm. Length and Width; or Diameter; Thickness
Comments	Recording any extra information not already included, or any distinguishing characteristics	Written narrative

Table 2.3. Artifact Variables and Analytic Procedures.

Mano Cross-Section

Mano cross-sections, also referred to as profiles, were historically considered to represent the end products of different mano types. However, Adams has shown through experimental archaeology that mano profiles represent a combination of the original form of the tool blank, use history and wear management strategies. To counteract uneven wear, the distal and proximal edges of the tool may be switched, or the tool may be flipped over. Depending upon the original shape of the tool, this results in the following mano profile shapes (Table 2.4). Mano profiles are an important variable to consider because they represent culturally determined preferences for tool shape, material, grinding stroke pattern, and wear management strategy.

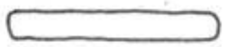
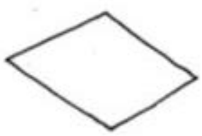
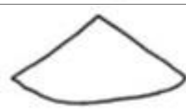
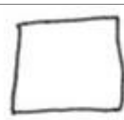
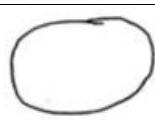
Profile Shape	Letter Code	Description
	**A**	**Tabular**
	**B**	**Wedge**
	**C**	**Triangular**
	**D**	**Diamond**
	**E**	**Rocker**
	**F**	**Domed**
	**G**	**Rectangular**
	**H**	**Cobble**

Table 2.4. Mano Profile Shapes.

Efficiency and Use Intensity

The concept of mano efficiency is not included in Crow Canyon's Laboratory Manual but is highly emphasized by Adams. Efficiency is defined as the "output of ground product per unit of time" (Adams 2014:122). By creating more efficient manos, a community could either spend less time producing the same amount of product, freeing up women's time for other activities, or grind more product in the same amount of time, either allowing a surplus to be generated or a larger population to be fed. Adams suggests that "relative efficiencies might be measured by the size of the grinding surface and the weight of the tools" (2014:30). For this study, I calculate grinding surface area as grinding surface length times width, rather than the total artifact length times width. I then plot grinding surface area against artifact weight. Geib asserts that "length is the principle dimension that determines mano grinding surface because widths are far less variable—generally as wide as can be tolerably gripped by the average female hand" (2004:2.137).

Use intensity of a tool is the amount of time it is used to grind in one session or for one task. Intensively used tools are used for long grinding sessions, whereas extensively used tools are used for shorter sessions but many times. If only the degree of wear were considered, intensively and extensively used tools might appear identical in the archaeological record. The presence of comfort features, such as thumb or finger grooves and grips to facilitate an easier grasp of the tool, indicate "the tool was more likely intended for intensive" grinding sessions (Adams 2014:52). Adams argues that when degree of wear is considered collectively with comfort features and tool efficiency, intensively and extensively used grinding tools can be differentiated.

CHAPTER THREE

GROUND STONE ANALYSIS

Analyzing the data from varied perspectives addresses a wider variety of research questions and more precisely answers questions of ground stone manufacture and use. First, I examine the complete assemblage to orient the reader. Next, I compare the assemblage from the Dillard site to the hamlets, highlighting tool needs at each. Then, I analyze the ground stone assemblages from each of the sample sites, highlighting the tool needs at the individual hamlets. Intra-site dynamics are examined through an analysis of ground stone by architectural block at the Dillard site, and by structure functional categories at both Dillard and the hamlets, providing additional scales of comparison.

Overall Assemblage

Basic Variation of the Sample

The assemblage consists of 159 ground stone tools from the six sample sites. Manos (n=63, 40%) and metates (n=58, 36%) are the most common, followed by abraders (n=30, 19%), with polishing stones, mauls, and a stone mortar and pestle comprising the remaining 5% (n=8). Table 3.1 outlines key variables by artifact type. To simplify tables, mano and metate types are combined unless the differences between types are being examined. A slight majority of the artifacts were incomplete (47%), followed by complete (40%). Fragmented artifacts are less likely to be identifiable and are primarily cataloged with bulk indeterminate ground stone samples.

Variable	Mano		Metate		Pestle		Stone Mortar		Abrader		Polishing Stone		Maul		Grand Total	
	n	%	n	%	n	%	n	%	n	%	n	%	n	%	n	%
Condition																
Complete	31	49.2	7	12.1	1	100	0	0	21	70	3	100	1	33.3	64	40.3
Incomplete	28	44.4	40	69	0	0	1	100	5	16.7	0	0	1	33.3	75	47.2
Fragment	4	6.3	11	19	0	0	0	0	4	13.3	0	0	1	33.3	20	12.6
Total	63	100	58	100	1	100	1	100	30	100	3	100	3	100	159	100
Material																
Sandstone	42	66.7	54	93.1	1	100	1	100	30	100	0	0	0	0	128	80.5
Quartzite	9	14.3	0	0	0	0	0	0	0	0	1	33.3	0	0	10	6.3
Igneous Rock	2	3.2	0	0	0	0	0	0	0	0	1	33.3	2	66.7	5	3.1
Unknown Sil. Sand.	5	7.9	0	0	0	0	0	0	0	0	1	33.3	0	0	6	3.8
Dakota/Burro Can Sil. Sand.	3	4.8	1	1.7	0	0	0	0	0	0	0	0	0	0	4	2.5
Morrison Sil. Sand.	2	3.2	3	5.2	0	0	0	0	0	0	0	0	0	0	5	3.1
Morrison Mudstone	0	0	0	0	0	0	0	0	0	0	0	0	1	33.3	1	0.6
Total	63	100	58	100	1	100	1	100	30	100	1	100	3	100	159	100
Degree of Wear																
Light	5	7.9	10	17.2	1	1	0	0	5	16.7	2	66.7	0	0	22	13.8
Moderate	13	20.6	28	48.3	0	0	0	0	18	60	1	33.3	0	0	61	38.4
Heavy	45	71.4	20	34.5	0	0	1	100	7	23.3	0	0	3	100	76	47.8
Total	63	100	58	100	1	100	1	100	30	100	3	100	3	100	159	100
Design																
Expedient	6	9.5	11	19	1	100	0	0	28	93.3	3	100	0	0	49	30.8
Strategic	57	90.5	47	81	0	0	1	100	2	6.7	0	0	3	100	110	69.2
Total	63	100	58	100	1	100	1	100	30	100	3	100	3	100	159	100
Use																
Multiple-use	13	20.6	3	5.2	1	100	0	0	7	23.3	3	100	1	33.3	28	17.6
Single-use	50	79.4	55	94.8	0	0	1	100	23	76.7	0	0	2	66.7	131	82.4
Total	63	100	58	100	1	0	1	100	30	100	3	100	3	100	159	100
Number of Ground Surfaces																
0	0	0	0	0	0	0	0	0	0	0	0	0	3	100	3	1.9
1	19	30.2	43	74.1	0	0	0	0	22	73.3	1	33.3	0	0	83	52.2
2	44	69.8	13	22.4	0	0	0	0	8	26.7	2	66.7	0	0	67	42
3	0	0	2	3.4	0	0	1	100	0	0	0	0	0	0	4	2.5
4	0	0	0	0	1	100	0	0	0	0	0	0	0	0	1	0.6
Total	63	100	58	100	1	100	1	100	30	100	3	100	3	100	159	100

Table 3.1. Condition, Material, Degree of Wear, Design, Use, and Number of Ground Surfaces by Artifact Type.

Sandstone, the most immediately available raw material in the study area, predictably dominates the assemblage (n=128, 81%). In addition to the convenience of using such a nearby resource, sandstone is an excellent material for grinding tools, so it is not the case that Ancestral Puebloans were sacrificing quality of material for local availability. Quartzite is the next most utilized material type (n=10, 6%), and 90% of the quartzite artifacts are manos, likely because it is found in cobbles that lend themselves well to use as manos. Igneous rock (n=5) only represents 3% of the sample, but is the predominant material used for mauls and is also used for two of the manos. Igneous rock is often found in cobbles in this region, and can be polished to a smooth consistency, making it an excellent material for artifacts that are either polished themselves or have a polishing function. Apart from one maul made of Morrison Mudstone (1%), the remaining 15 artifacts are made of three additional varieties of silicified sandstone (9% collectively).

The assemblage is 48% heavily worn, with an additional 38% exhibiting moderate wear. This demonstrates that artifacts were well-used before discard or recycling, though intensive or extensive use cannot be discerned by examining degree of wear alone. It may also be true that assemblages are biased toward heavily worn artifacts because they accumulate throughout a site's occupation, as the end product of used ground stone tools. Fine-grained material constituted 80% of the assemblage and was the predominant granularity for all artifact types apart from mauls. This is because the locally available sandstone is almost always fine-grained and represents the most commonly used material. Each other material type is more evenly split between granularities.

Because such a high percentage of the assemblage is heavily worn and made from fine-grained material, artifact surface coarseness was often manually increased through pecking. Manos, metates and abraders all exhibited pecking, though a higher number of metates were pecked (n=39, 67%), followed by manos (n=39, 62%) and abraders (n=7, 23%). Manos wear out much more quickly than metates (Adams 2014), so it follows that their grinding surfaces would need to be pecked more often. Though the Crow Canyon Laboratory Manual specifies that abraders are not pecked, this was clearly not the case for the study sites. This suggests that some abraders were used for activities which required coarse surfaces, perhaps shaping tougher objects. Another likelihood is that abraders were carefully chosen by their users, who saw it as a worthwhile investment to rejuvenate their surfaces, rather than finding another suitable piece of sandstone.

Most artifacts were used only on one surface (52%), though both manos and polishing stones were more often used on two surfaces. Metates had the most varied number of ground surfaces, including artifacts with one, two and three ground surfaces (Table 3.1). Additionally, considering that 69% of artifacts were strategically made, and that 82% were single-use, it appears that artifacts were not simply created when a tool was needed, but carefully designed for a specific purpose and used heavily until they were no longer effective. Because the assemblage is so strongly dominated by manos and metates, however, the sample is biased toward characteristics of those artifact types. Later sections will address these variables for specific artifact types, parsing out the different specifications of their design and manufacture.

Though grinding tools, particularly manos and metates, were often used to grind corn or other seeds, they were also commonly used for other purposes. Adams states that traces of pigment are often invisible to the unaided eye. Because microscopes were not used to conduct analyses of artifact surfaces, the exact number of artifacts containing traces of pigment was not determined, however, pigment was macroscopically visible on some artifacts. Table 3.2 lists the color of pigment for each artifact, though two abraders did not have pigment color specified. Though this study will not further analyze the pigments, noting their presence is critical to account for the diversity of grinding tool uses beyond grinding maize. The red to yellow and black pigments indicate that decorative pigments, such as pigments for pottery and body decorations, were being ground. There was no indication of ground clays, which in the local region are gray.

Munsell Color	**Color**	**Mano**	**Metate**	**Abrader**	**Polishing Stone**	**Grand Total**
10R 4/6	Red	0	0	0	1	1
10R 4/8	Red	1	0	0	0	1
2.5YR ¾ to 5/8	Dark reddish brown to red	0	1	0	0	1
2.5YR 2.5/3	Dark reddish brown	0	1	0	0	1
5YR 5/6	Yellowish red	1	0	0	0	1
7.5YR 6/8	Reddish yellow	0	1	0	0	1
GLEY 2.5/N	Black	1	0	0	0	1
(Blank)	Not specified	0	0	2	0	0
Total		3	3	2	1	9

Table 3.2. Artifacts with Pigment.

Grinding strokes may leave macroscopically visible striations that reflect the direction of the stroke. The linear or multidirectional pattern of striations can be used to determine whether a grinding tool was used with what Adams refers to as reciprocal or circular strokes, respectively (2014). Though this analytic variable is intended to capture data most relevant to manos and metates, all artifact types represented in this study, apart from mauls, contained at least one artifact which had visible striations. One-hand manos are typically thought to be used with a circular motion, leaving multidirectional striations, and two-hand manos are understood to be used in a reciprocal motion, leaving linear striations. Figure 3.1 separates mano and metate types and shows this is not always true. Both one-hand and two-hand manos had more linear striations, though two-hand manos had a higher percentage, and both striation directions are represented in each type.

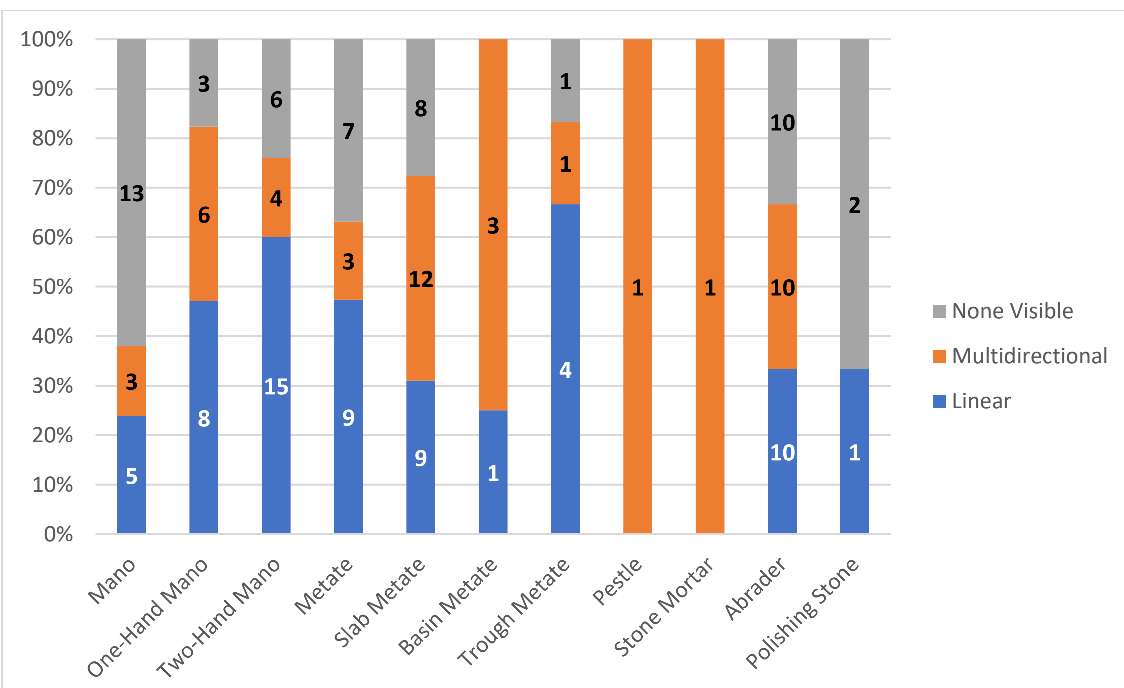


Figure 3.1. Striation Pattern by Artifact Type.

The samples of all types of manos and metates, as well as abraders, contained both artifacts with linear striations and multidirectional striations. Two-hand manos and trough metates were dominated by artifacts with linear striations, and slab and basin metates had predominantly multidirectional striations, as would be expected. However, this graph shows that long-held assumptions about grinding strokes needs to be reexamined. While the assumptions may hold true in most cases, it should not be assumed to be true without further analysis. In a more detailed study, a microscopic use wear analysis could not only provide more information on stroke patterns, but what types of substances are processed with which strokes on which type of artifact. This higher level of detail could provide many insights into dynamics of production in communities.

Manos

Differentiating the mano categories is important to understand the different manufacture and uses of each type. Descriptive statistics (Table 3.3) of each artifact dimension provide a preliminary avenue to examine the data. Discrepancies in artifact counts between length, width and other variables is a result of some manos not having a length or width recorded but a diameter instead. Additionally, not all artifacts had a second grinding surface, meaning the count was also smaller for that category. Only complete artifacts were considered in order to ensure measurements accurately represent full artifact dimensions. This excludes untyped manos, which are, by definition, incomplete or fragmented.

	Weight (g)		Length (cm)		Width		Thickness		Surface 1 Area		Surface 2 Area	
Mano Type	One-Hand	Two-Hand	One-Hand	Two-Hand	One-Hand	Two-Hand	One-Hand	Two-Hand	One-Hand	Two-Hand	One-Hand	Two-Hand
Mean	930.2	1274	12.7	18.6	9.6	11.5	5.3	3.6	87.6	195.2	82.5	149.8
Median	804.4	1047.9	12.1	18.3	9.3	11.7	5.4	3.1	81	209.1	73.5	161.7
Stand. Dev.	382.2	488	2.3	1.7	1	0.8	1.4	1.1	33	31.8	38	43
Range	1386.8	1802.8	6.7	6.9	3	3.5	4.5	3.4	117.8	118.4	131.2	166.7
Min.	584.7	677.7	9.9	16	8.6	9	3.7	2.3	45.8	122.4	34.3	34.4
Max.	1971.5	2408.5	16.6	22.9	11.5	12.5	8.2	5.6	163.5	240.8	165.6	201.1
Count	13	17	12	17	12	17	13	17	13	17	11	11

Table 3.3. Descriptive Statistics for Dimensions of One-Hand and Two-Hand Manos.

By definition, two-hand manos are larger than one-hand manos, so it follows that their average dimensions are larger. In this sample, weight and length are significantly larger for two-hand manos. Width is also larger but less dramatically so, because manos have an absolute maximum width that allows the grinder to grip the tool and control their grinding motion (Geib 2004); this is also reflected in the smaller standard deviations for widths of both mano types. Thickness is the only variable that is smaller for two-hand manos, and as Figure 3.2 suggests, this is likely correlated to the much heavier wear of two-hand manos. However, the average thickness of manos with light wear shows that one-hand manos are much thicker to begin with, 6.1 cm on average compared to 3.7 cm for two-hand manos. Thickness is an important variable for one-hand manos: since their grinding surface area is considerably smaller, their grinding efficiency depended more on the extra weight given to the tool by its thickness. One-hand manos may also be thicker on average because they are often made from cobbles, while two-hand manos are often made of tabular sandstone.

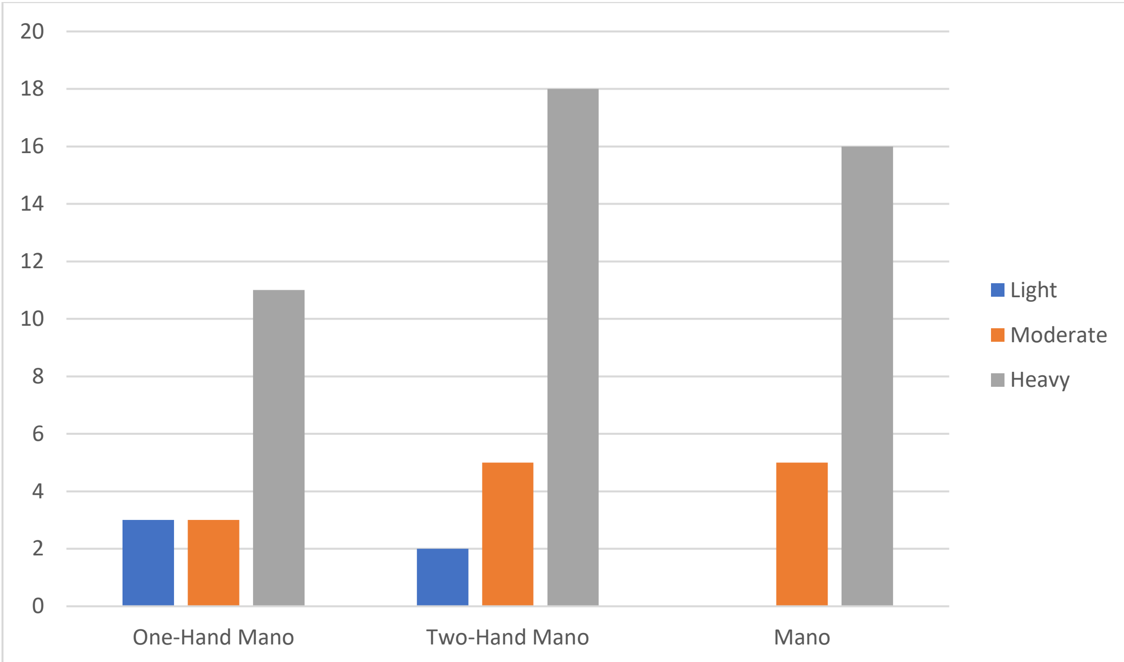


Figure 3.2. Degree of Wear by Mano Type.

Different percentages of lithic materials contributed to the one-hand mano and two-hand mano assemblages (Figure 3.3). Sandstone was the most commonly used material for both types, as well as the untyped mano category. For two-hand manos, though, sandstone comprised 76% of the artifacts, whereas for one-hand manos, sandstone was used for only 47% of the artifacts. The remaining two-hand manos were made of other silicified sandstone, and one was made of quartzite. For one-hand manos, quartzite was the second most commonly used material (24%), followed by silicified sandstone and one igneous mano. This indicates that different materials were chosen for one-hand and two-hand manos, perhaps because they were more efficient at the types of task each was used for. It is also likely that quartzite and igneous materials were chosen for one-hand manos because they occur in cobbles, which is a preferred form for one-hand manos. Quartzite cobbles rarely naturally occur in shapes long enough to be used for two-hand manos, and quartzite is stronger and less easily shaped than sandstone, the preferred material for two-hand manos.

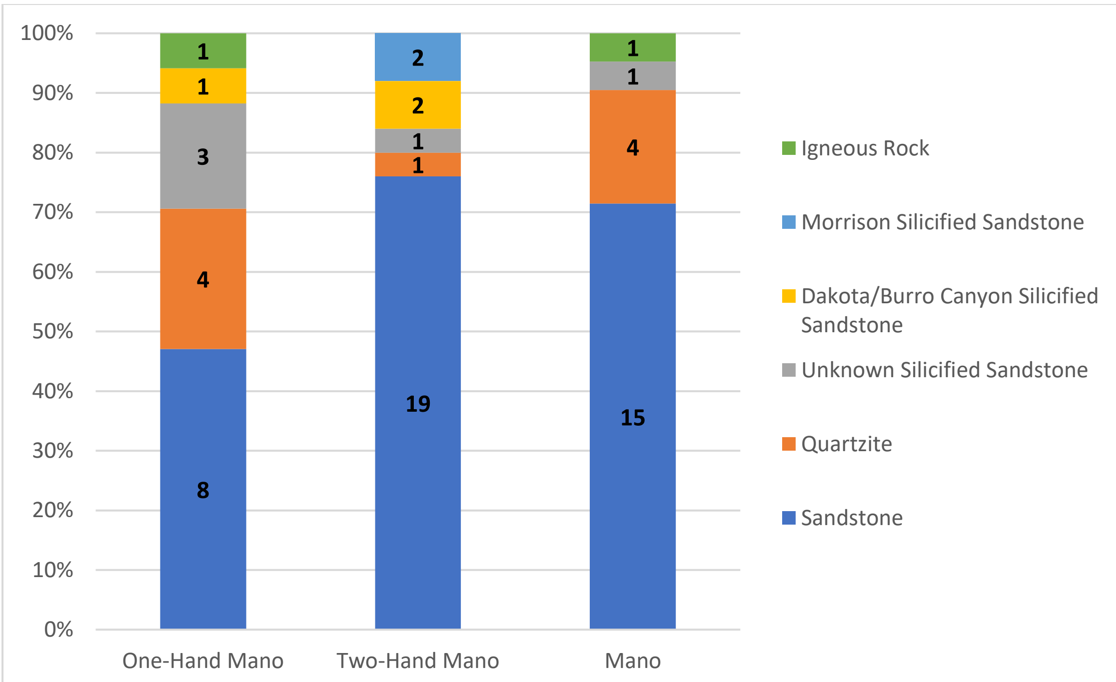


Figure 3.3. Material by Mano Type.

Design and use for each mano type are quite distinct (Figure 3.4). One-hand manos include both expediently- and strategically-made tools, and each category contains both single- and multi-use tools. Expedient tools are more likely to be multiple-use, and strategic tools are much more likely to be single use, suggesting there are informal and formal tool categories for one-hand manos. Two-hand manos, however, were exclusively strategic, and 88% were single-use. These differences indicate that two-hand manos were a more formal tool type than one-hand manos.

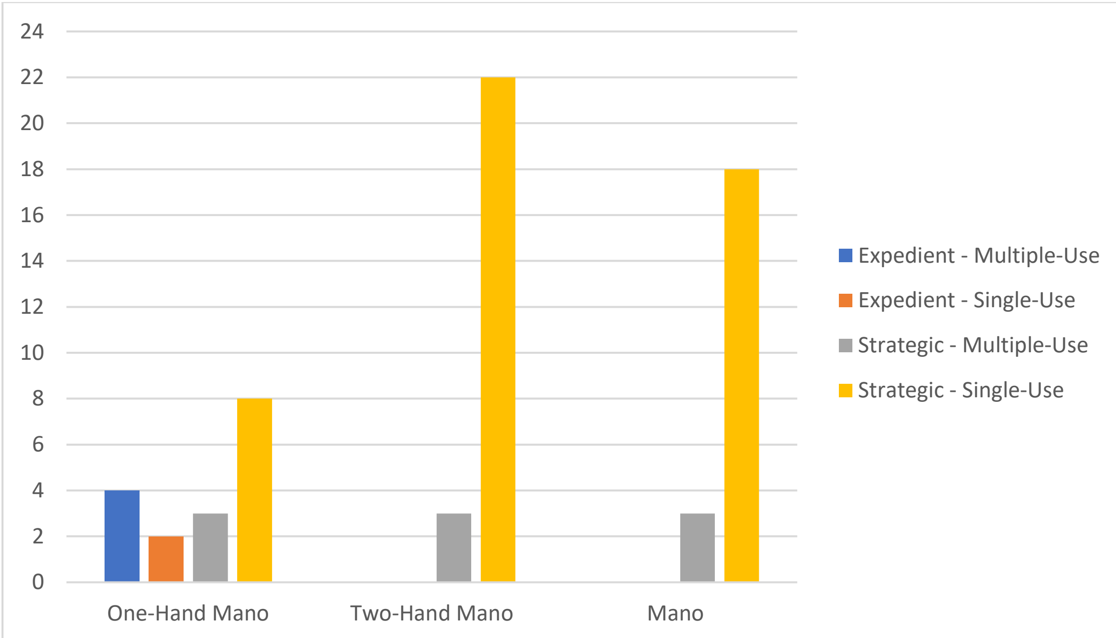


Figure 3.4. Design and Use by Mano Type.

An additional form of tool investment is the use of pecking to increase surface coarseness. One-hand manos have about the same frequency of pecked and unpecked manos. The two-hand mano sample, on the other hand, has four times the number of manos with increased coarseness as without (Figure 3.5). This indicates that more effort was invested to keep two-hand manos in working condition. Two-hand manos are, it seems, formal tools that were created to be as effective as possible at producing ground product. One-hand manos were used for a variety of purposes and were sometimes unaltered before being used. This supports the adequacy of one-hand and two-hand categories to describe differences in mano manufacture and use. This should not be taken to mean that one-hand and two-hand manos had separate uses, or that they could not be used for the same purposes.

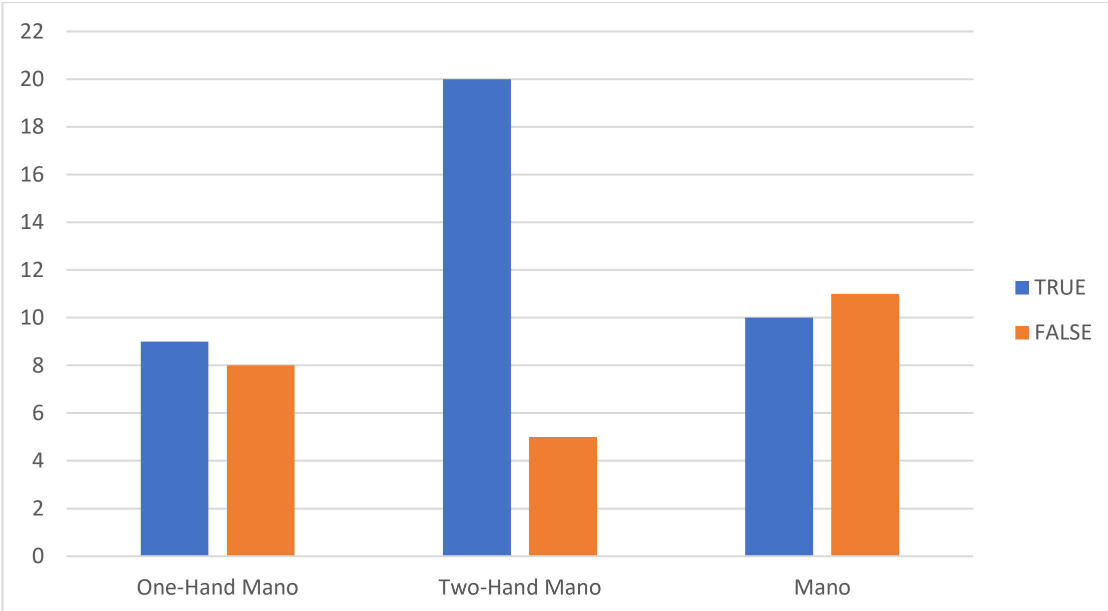


Figure 3.5. Increased Coarseness by Mano Type.

Another important mano attribute is cross-section. The cross-sections or profiles reflect the wear management strategy used with the mano. Table 2.4 listed profile shapes and associated codes, though only codes A (tabular), B (wedge), F (domed), and H (cobble) are represented in this sample. One-hand and two-hand manos have different profiles, with limited overlap (Figure 3.6). One-hand manos were predominantly cobbles (71%), with 18% each of the domed and tabular types, and one wedge profile. Two-hand manos were 70% tabular, 22% domed, and the remaining two manos were wedge. While wedge and domed are a smaller percentage of both mano types, the tabular type is much more common for two-hand manos, and cobbles are exclusive to one-hand manos. This shows that each mano type was designed and their wear managed differently, though overlap exists. The tabular profile of two-hand manos also results from their formal shaping, as well as the malleability and natural shape of sandstone in this region.

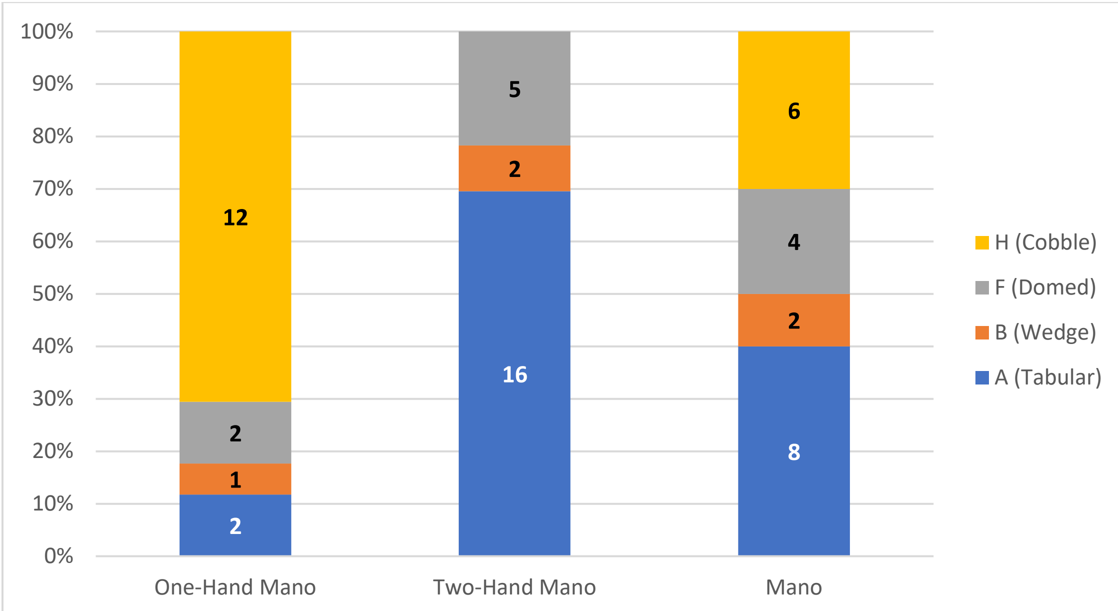


Figure 3.6. Cross-Section of Mano Types.

Metates

Each of the metate types, though serving similar functions, has distinctions from the others in size and design attributes. Table 3.4 lists average dimensions for variables of each metate type. Both the trough and basin categories contained only one complete artifact; these were taken to represent their metate types. Slab metate dimensions are based on the mean of each variable from the five complete artifacts. There are significant size differences between types. Grinding surface, as mentioned previously, is the area of the tool that was in contact with another surface during grinding. The grinding surface area of the trough metate is 792 cm^2, almost 40 cm^2 larger than the slab metates and over 400 cm^2 larger than the basin metate. These surface areas result in significantly different grinding outputs, with trough metates capable of containing more ground product, and providing a much larger work surface on which to grind that product. Interestingly, trough metates are significantly thinner than both other types, perhaps because they are more extensively manufactured, reducing their original shape and size.

Variable	Slab Metate (n=5)	Basin Metate (n=1)	Trough Metate (n=1)
Weight (kg)	13.5	10.8	20
Length (cm)	40.8	36	53
Width	28.2	32.3	36
Thickness	8.2	12.5	5
Surface 1 Area	752.8	390	792
Trough Length	N/A	N/A	36
Trough Width	N/A	N/A	22
Trough Depth	N/A	N/A	2

Table 3.4. Average Dimensions of Metate Types.

The degree of wear for each metate type reflects different use intensities. Trough metates are predominantly heavily worn (83%), while basin metates are slightly less heavily worn (75%) (Figure 3.7). Slab metates were significantly less worn: the majority (59%) exhibited only moderate wear, and 27% had light wear. The heavier use of trough metates in addition to their necessarily strategic design suggests that they were created to grind a large amount of product. Basin metates are also heavily used; this would follow the significantly lower number of heavily worn slab metates, suggesting that what are termed basin metates may be the heavily worn slab metates. Adams (2014) warns that the two may be difficult to discern as intentional basin shaping may be obscured by use wear, making them appear almost the same as a well-worn slab metate that has a depression from continued use in the same places on its surface.

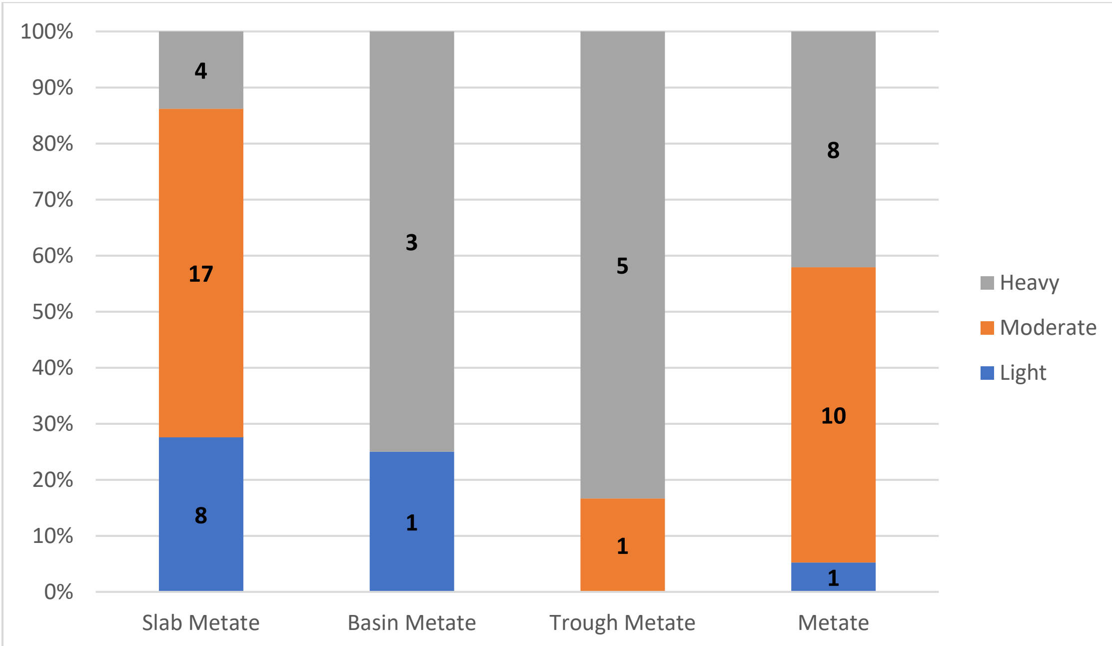


Figure 3.7. Degree of Wear for Metate Types.

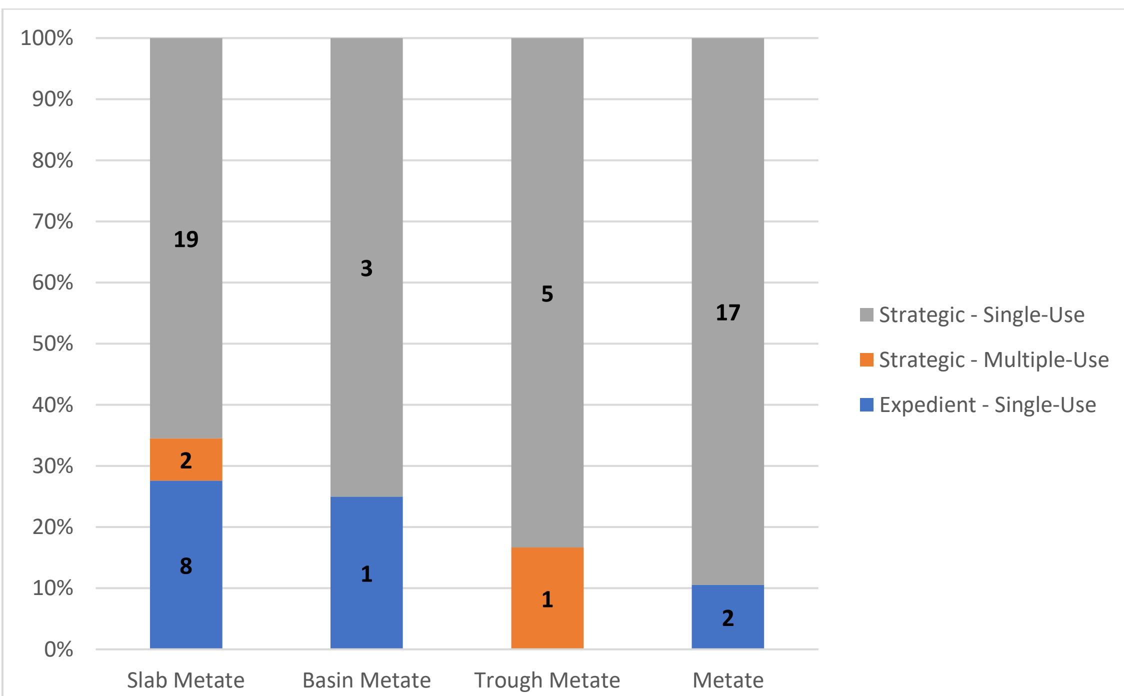


Figure 3.8. Design and Use by Metate Type.

The majority of metates were strategically-made and single-use (Figure 3.8), the most formal category, which emphasizes their specific design for a single purpose. Slab and basin metates were sometimes expediently designed, but of the two, only slab metates were multiple-use tools, their flat surfaces being the ideal work surface for many purposes. Perhaps unexpectedly, one of the trough metates (representing 17% of its type) was multiple-use despite its formal design.

Using uniformity of lithic material as another indication of tool formality, trough metates were the most standardized, followed by basin and slab metates (Figure 3.9). Trough metates were also pecked to increase coarseness at the highest rate (Figure 3.10). In addition to their heavy wear and strategic design, this high percentage of pecking shows higher investment in trough metates, with basin metates a slightly less utilized and formal category and slab metates the least utilized and least formal of the metate types.

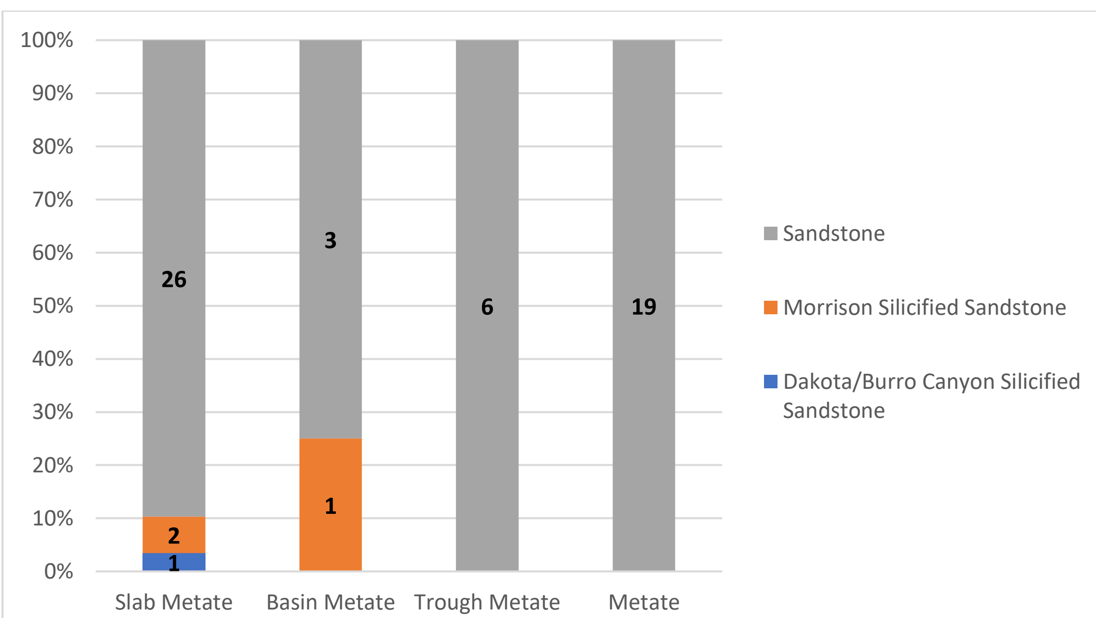


Figure 3.9. Material by Metate Type.

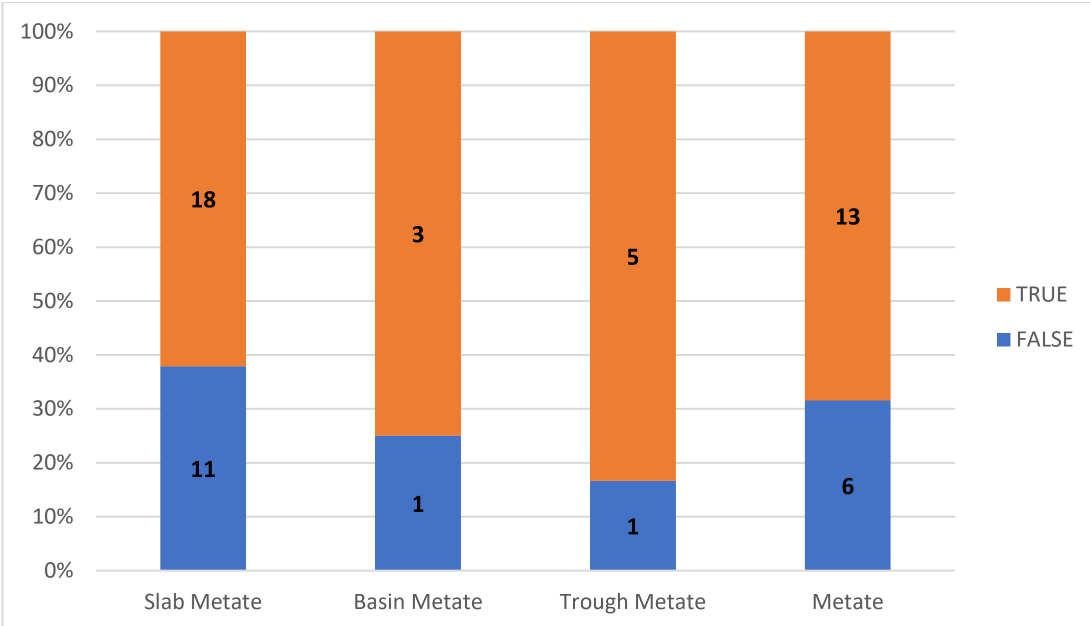


Figure 3.10. Increased Coarseness by Metate Type.

Abraders

Abraders were the most common artifact category after manos and metates, representing 19% of the assemblage (n=30). Abraders are useful for working a variety of materials actively or passively, do not require much manufacturing or redesign to perform effectively, and can be easily made from recycled materials, all likely leading to their abundance throughout the study area. Table 3.5 lists descriptive statistics for complete abraders (n=21) in the assemblage. Length, width, and thickness were not particularly variable, showing that rocks of roughly similar size were selected. However, weight varied dramatically, with a range of 1941.6 g and standard deviation of 534.1 g. There were several heavy abraders, and likely these represent passive abraders, while smaller abraders may have been used actively.

	Weight (g)	Length (cm)	Width	Thickness	Surface 1 Area	Surface 2 Area
Mean	549.8	10.7	8.3	3.5	64.9	60.7
Median	534.1	3.1	2.4	1.7	45.8	60.9
Standard Deviation	441	10.7	7.5	3.1	53.3	14.9
Range	1941.6	9.8	8.1	6.6	205.3	78
Min.	105	6.2	4.9	1.2	2.8	27
Max.	2046.6	16	13	7.8	208	105.1
Count	21	21	21	20	21	5

Table 3.5. Descriptive Statistics for Abraders.

Abraders were overwhelmingly expediently designed (93%), and single-use (77%). All the multiple-use abraders were expediently designed (n=7, 23% of total). However, this study does not differentiate between grooved and non-grooved abraders, between U-shaped and V-shaped grooved abraders, nor between abraders used in contact with different material types such as wood, bone, and stone. The single-uses of abraders may, therefore, be more varied than mano and metate uses, for example. Additionally, no distinctions are made between passively- and actively-used abraders. Thus, it is important to remember that the category of abrader is an archaeological construct, albeit a useful one. For example, all abraders were made of sandstone, suggesting the adequacy of this artifact type to accurately represent a distinct category of objects.

Striations on abraders were evenly split between linear, multi-directional and none visible (n=10 each). This again highlights the many different uses and functions of abraders. As mentioned previously, 23% of the abraders (n=7) were pecked to increase coarseness. Crow Canyon's Laboratory Manual specifies that abraders are not pecked, however, Figure 3.11 shows that pecked abraders are more likely to be multiple-use tools, suggesting that the pecking is related to their other uses. Though the majority of abraders did not have grooves (n=23), three abraders had one groove each, and the remaining four abraders had two, three, four, and five grooves, respectively. Lastly, only two abraders had pigment present, out of nine artifacts with pigment in the assemblage, though the pigment color was not recorded for either artifact.

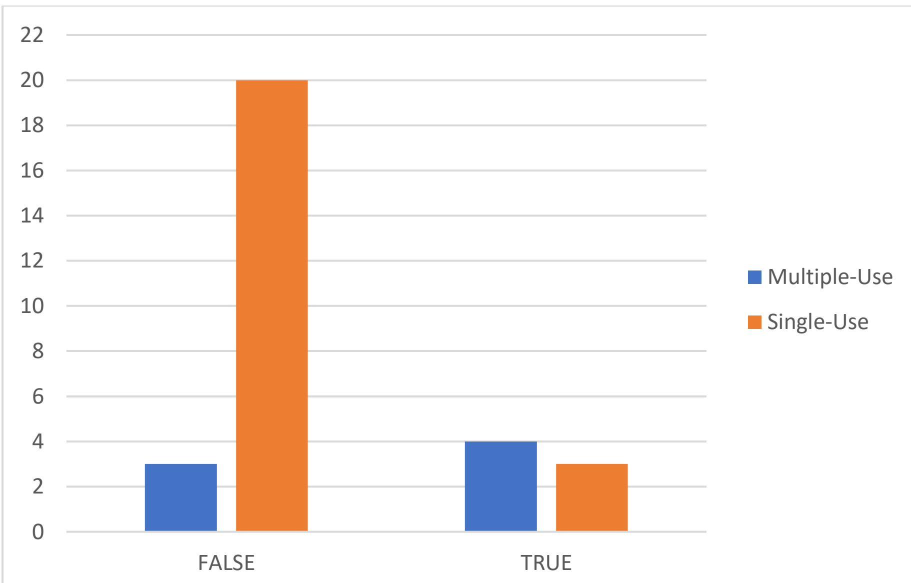


Figure 3.11. Abraders by Use and Increase Coarseness.

Additional Artifact Types: Pestle, Stone Mortar, Polishing Stone, Maul

The remaining artifact categories are present in numbers too small to analyze in the same manner as the previous sections, however, their basic attributes are important to note. Table 3.6 identifies these attributes, and for categories with more than one artifact, the mean of each variable for complete artifacts is listed. The stone mortar was a fragment, but since it is the only artifact of its kind, incomplete variables are listed to give a sense of artifact dimensions.

Variable	Pestle	Stone Mortar	Polishing Stone	Maul
Count	1	1	3	3
Complete Artifacts	1	0	3	1
Material	Sandstone	Sandstone	Igneous rock (n=1), Unknown Silicified Sandstone (n=1), Quartzite (n=1)	Igneous rock (n=2), Morrison Mudstone (n=1)
Weight (g)	1719.8	2984.5	674.6	633.9
Length (cm)	17	22.1	12.8	11.4
Width	9.5	11.3	8.6	8.5
Diameter	0	0	0	0
Thickness	7.8	7.1	4.3	4.4
Surface 1 Area	80.2	98.5	59	0
Surface 2 Area	69.4	220	62.3	0
Surface 3 Area	52.6	0	0	0
Surface 4 Area	50	0	0	0

Table 3.6. Basic Variables of Pestle, Stone Mortar, Polishing Stone, and Maul.

The pestle and stone mortar, though not found in the same structure, are both from the Dillard site (5MT10647). There is no mention in the artifact analyses whether these artifacts were compatible, though it is possible. In any case, they represent the multiple grinding strategies that were used at the Dillard site. The pestle is expediently designed and multiple-use; it was primarily used for crushing and grinding on its ends but was also used to grind flat on its sides. The stone mortar was strategically designed for its previous use as a metate, but is a single-use tool, only used as a netherstone (inactive element) for grinding. The pestle is moderately worn, while the stone mortar is heavily worn, though both were pecked to increase coarseness. Both have multi-directional striations from their use in crushing, stirring and grinding materials.

There are three polishing stones in the assemblage, each from a different site. This suggests that polishing stones, while not an abundant tool, were necessary for each community to maintain their plastered walls and floors. Materials consist of igneous rock, quartzite, and unknown silicified sandstone, and all were naturally occurring river cobbles. They are all expedient, multiple-use tools. Comments specify that one has 10R 4/6 red pigment present that might be plaster. Another was used as a one-hand mano, a pecking stone, and then a polishing stone. The third has battered ends from pecking. Two have light wear, and one is moderately worn. All three had two use surfaces, one on each face of the artifact, suggesting they were used on one side and flipped over as necessary.

Two of the three mauls in the assemblage are from the Ridgeline site and the remaining maul is from the Dillard site. Both mauls from Ridgeline are made of igneous material, while the Dillard maul is made of Morrison Mudstone, perhaps suggesting different material preferences between the sites, though the small sample size makes it difficult to discern. All mauls are strategically designed by definition and have heavy wear with no visible striations since they were not used for grinding. One has pecking and burning on one end while the other two are single-use.

Comparisons Between The Dillard Site and The Hamlet Sites

Comparing the ground stone assemblages between the Dillard site and the other sites in the sample, referred to as hamlets, provides many insights about the tool needs and specifications of a larger aggregated site compared to smaller habitations. Not only was the residential population larger at the Dillard site, but the temporary population would have significantly increased when the great kiva was used for large-scale gatherings and the temporary habitations were occupied. Food processing tools may provide insight into intensive versus extensive use and the time commitments required for each. Different types of ground stone tools may have been necessary for a wider variety of tasks at the Dillard site, whereas the hamlet assemblages may consist of tools used for basic domestic tasks. Additionally, choices such as material type and wear management strategies reflected in mano profiles indicates specific, culturally-determined preferences of the occupants of different sites.

Because the Dillard site was so much larger than the hamlets, I use a simple method found in Till and Ortman (2007) to compare the relative sizes of the Dillard and hamlet sites' assemblages: compare the weights of grayware pottery from each site. This also reflects the amounts of excavation at each. Till and Ortman specifically estimate the length of occupation of specific architectural blocks within a site, though grayware pottery is often used as a baseline representation of a site's artifact accumulation in studies conducted by Crow Canyon (Schleher 2019, personal communication). Though this is a coarse method, it does provide a way to compare the extent of excavation for sites that are drastically different in scale.

The method of calculating site occupation length by grayware accumulation was originally advocated by Varien, who “view[s] the accumulation rate of cooking-pot sherds as a general constant related to population and the length of site occupation” (1999:66). Grayware pottery at Ancestral Puebloan archaeological sites is utilitarian ware, used for cooking and storing food and water, meaning that even when cultural change took place, potentially affecting other artifact classes, “cooking pots should accumulate in the archaeological record at relatively regular rates, so long as food preparation techniques, raw materials, and techniques of ceramic manufacture remain relatively constant” (Varien 1999:66).

Ground stone at the Dillard site totaled 137.1 kg, while the grayware weighed 84.1 kg, with a groundstone to grayware ratio of 1.6. At the hamlet sites, there was a total of 112.8 kg of ground stone and 36.9 kg of grayware, with a ground stone to grayware ratio of 3.1. If we accept that a ground stone to grayware comparison is meaningful, this indicates that ground stone was relatively less frequent at the Dillard site than at the hamlet sites. This might indicate that grinding was a higher priority at the hamlet sites, where smaller populations would need to feed themselves and might not have time to grind a surplus while still completing other household tasks.

The Dillard site has more ground stone artifacts total (n=102) than the hamlets (n=59), as well as a wider variety of artifact types (Figure 3.12). Grinding was extensively undertaken at both the Dillard site and the hamlets, though both the pestle and stone mortar were from the Dillard site, perhaps indicating use of a wider variety of grinding strategies. The majority (90%) of abraders were found at the Dillard site, strongly suggesting that craft or tool production was undertaken in a larger community setting, rather than at the smaller hamlets. Additionally, there were 76 peckingstones at the Dillard site and 20 from the hamlets, excluded from Figure 3.12. Peckingstones are included as a rough proxy for ground stone manufacture and maintenance but were also used for other tasks so their relationship to ground stone should be considered critically.

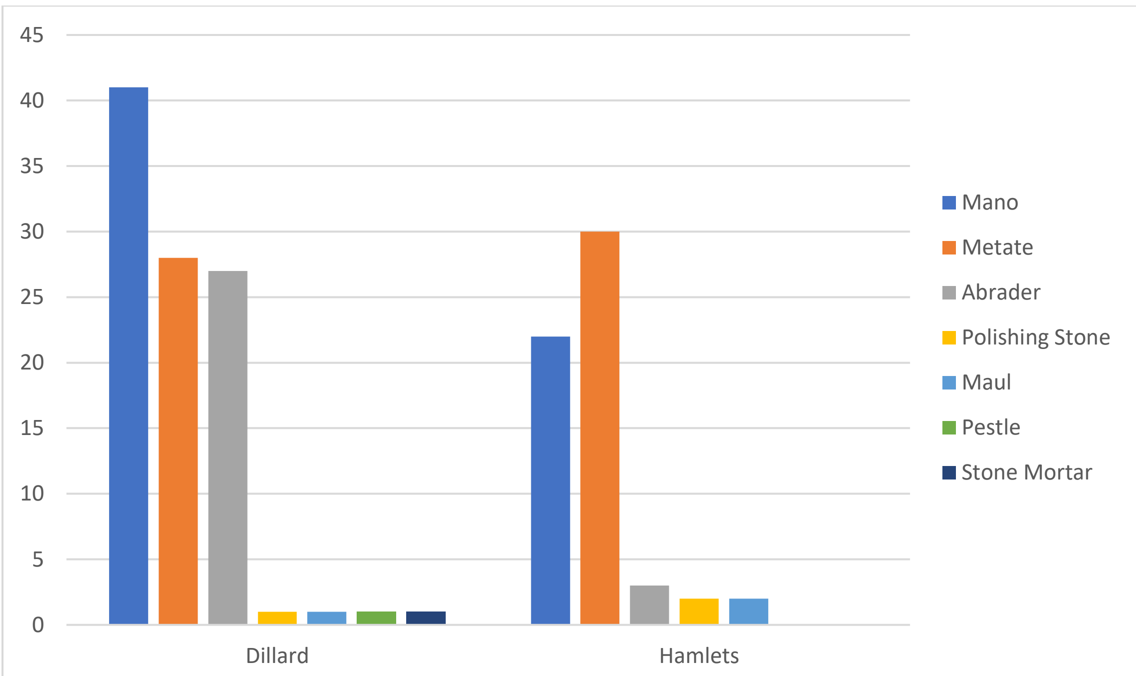


Figure 3.12. Ground Stone Artifacts at The Dillard Site and The Hamlet Sites.

Overall, residents of both the Dillard site and the hamlets used roughly the same number of material types, with some differentiation. Figure 3.13 shows that manos from the Dillard site are made from a wider variety of materials than those at the hamlets. Metates are more comparable between Dillard and the hamlets, and abraders even more so, as they are all made of sandstone. Polishing stones and mauls are too low in number to provide much insight. For manos, metates and abraders, both the Dillard site and the hamlet sites showed a strong preference for sandstone.

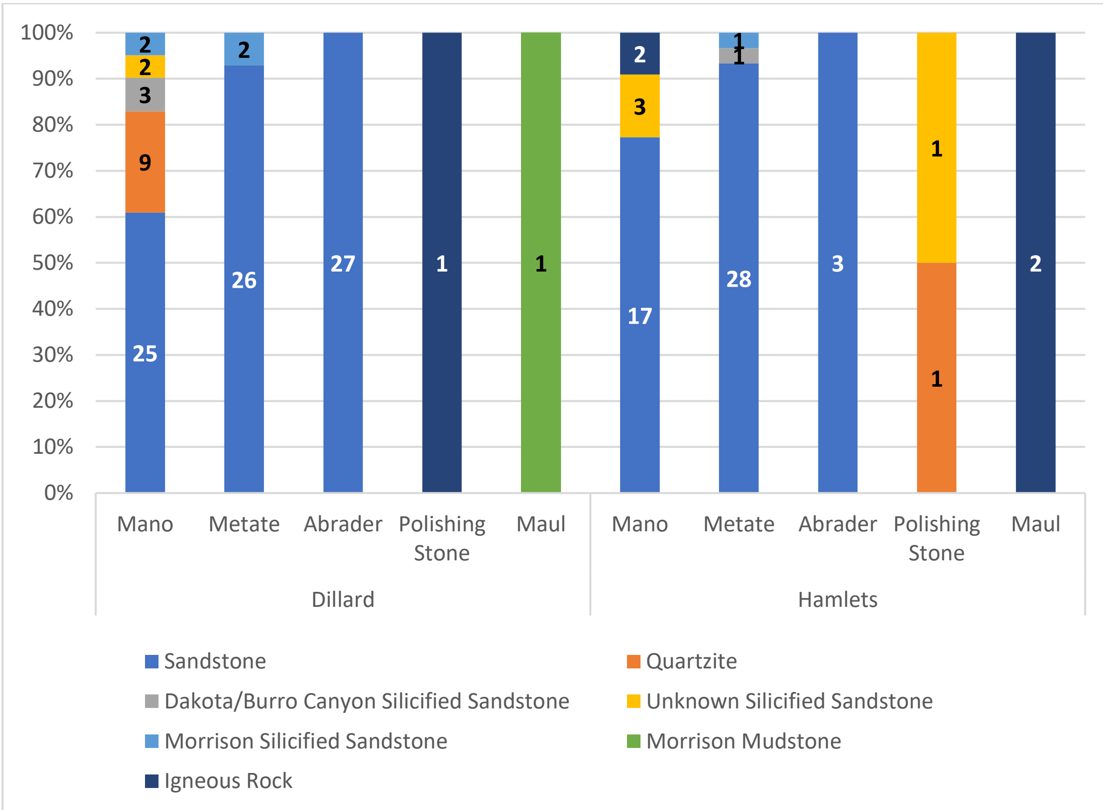


Figure 3.13. Material Types of Artifact Categories at The Dillard Site and The Hamlet Sites.

Considering the bulk indeterminate ground stone (BIG) assemblages provides further insight into material choice differences. Though sandstone was used for the vast majority of ground stone at both the Dillard site and the hamlet site (97% and 98% respectively), there were a total of nine material types present at the Dillard site compared to only four at the hamlets. The hamlets included only sandstone or silicified varieties and igneous rock, while the Dillard site additionally includes quartzites, conglomerate rock, and slate or shale. These distinctions exemplify the overwhelming preference for sandstone, as well as the secondary preferences for lithic material at the Dillard site and the hamlets.

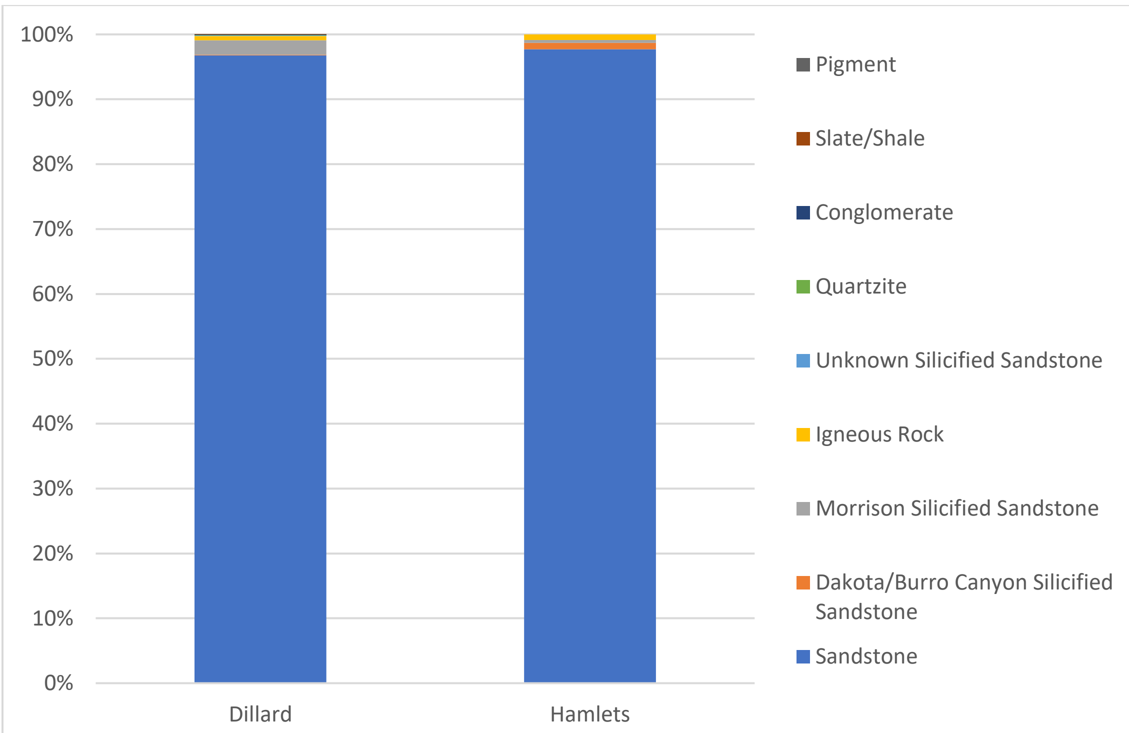


Figure 3.14. Material Types of Bulk Indeterminate Ground Stone at The Dillard Site and The Hamlet Sites.

Material	**Dillard Site**		**Hamlets Sites**		**Total Weight**
	Weight (g)	Percent	Weight (g)	Percent	
Sandstone	43,436.5	41	21,200.3	98	64,636.8
Dakota/Burro Canyon Silicified Sandstone	35.8	<1	213.7	1	249.5
Morrison Silicified Sandstone	18,892.2	18	116.3	<1	19,008.5

Unknown Silicified Sandstone	7,037.6	6	178.1	0	7,037.6
Igneous Rock	36,972.7	34	21,200.3	<1	37,150.8
Quartzite	37.5	<1	0	0	37.5
Conglomerate	14.3	<1	0	0	14.3
Slate/Shale	8.7	<1	0	0	8.7
Pigment	0.4	<1	0	0	0.4
Grand Total	106,435.7	100	0	100	149,852.5

Table 3.7. Weights of Material Types of BIG at The Dillard Site and The Hamlet Sites.

The presence of peckingstones also serves as a proxy for investment in ground stone tools, as peckingstones were used to shape and maintain grinding tools. They also served functions such as percussion and crushing, so their presence should be considered in relation to the actual evidence for pecking on ground surfaces. The Dillard site had exactly four times the number of peckingstones (n=76) than the hamlet sites (n=19). For both, Morrison silicified sandstone was the most common material, followed by Morrison mudstone, then by Dakota/Burro Canyon silicified sandstone. The Dillard site included two additional types (Morrison chert and Agate/Chalcedony), while the hamlet sites only included one more, an unknown quartzite. Comparing the peckingstone counts to the counts of artifact categories that had increased coarseness (mano, metate, pestle, stone mortar, abrader), the Dillard site (n=98) had a much higher ratio of peckingstones to ground stone objects than the hamlet sites (n=55). While this likely indicates that artifacts were more often pecked at the Dillard site, peckingstones also served multiple functions, so without further use wear analysis, it is unknown how many were used for pecking ground stone.

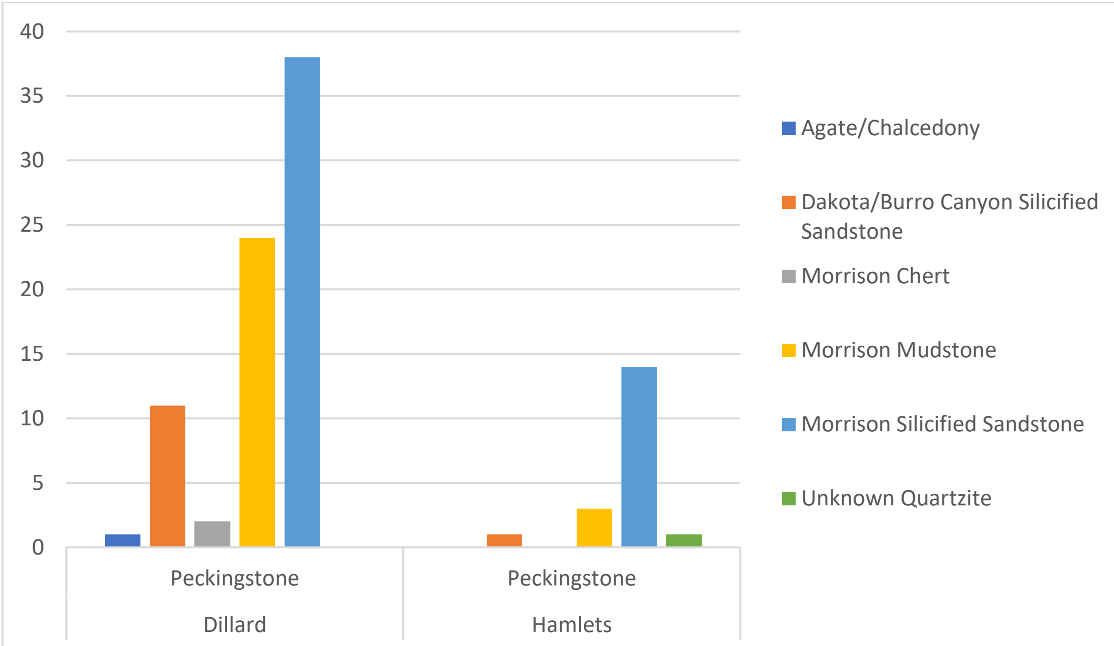


Figure 3.15. Material Types of Peckingstones at The Dillard Site and The Hamlet Sites.

Ground stone artifacts were more heavily worn at the Dillard site than the hamlets, with 54% of artifacts heavily worn, 37% moderately worn, and only 9% lightly worn. The hamlet sites' ground stone was only 37% heavily worn, 41% moderately worn, and 22% lightly worn. Additionally, as Figure 3.16 shows, strategically designed tools, or those with comfort features, were much more heavily used than expedient tools at the Dillard site. While strategic tools are still more heavily used than expedient tools at the hamlets, the difference is much less striking, perhaps indicating less of a divide in the way tools were used. Occupants of the Dillard site appear to have preferred well-designed tools, using them much more heavily, while the occupants of the hamlets were less concerned with shaping their tools before use, and those that were shaped were not as strongly preferred.

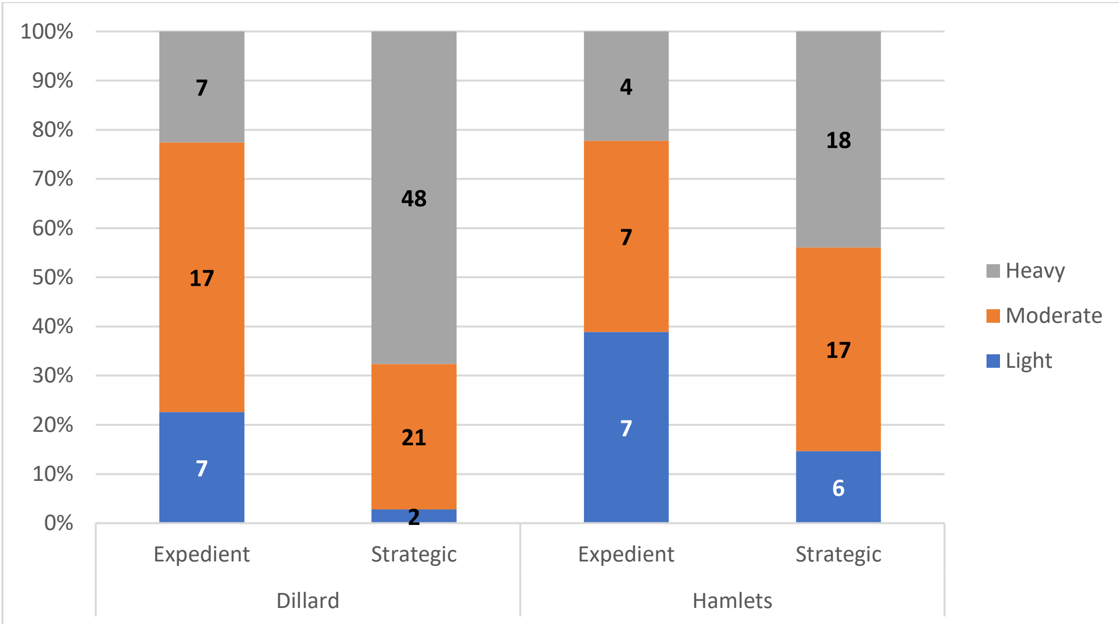


Figure 3.16. Design by Degree of Wear at The Dillard Site and The Hamlet Sites.

The Dillard site has a higher percent of strategic tools for all tool types than the hamlet sites. Figure 3.17 shows the percentages of expedient and strategic tools represented in both the Dillard and hamlet samples. This figure perhaps best expresses the distinct preference for strategic tools at the Dillard site. Comparing the occurrence of single-use and multiple-use tools shows that artifact types had roughly similar percentages of each use type at both the Dillard site and the hamlets. Figure 3.18 indicates that manos were more likely to be multiple-use at the hamlet sites than the Dillard site. There were more multiple-use abraders at the Dillard site than the hamlets, though there were ten times the abraders at the Dillard site. Other than these categories, the remaining artifacts were almost equally likely to be single- or multiple-use at both Dillard and the hamlets.

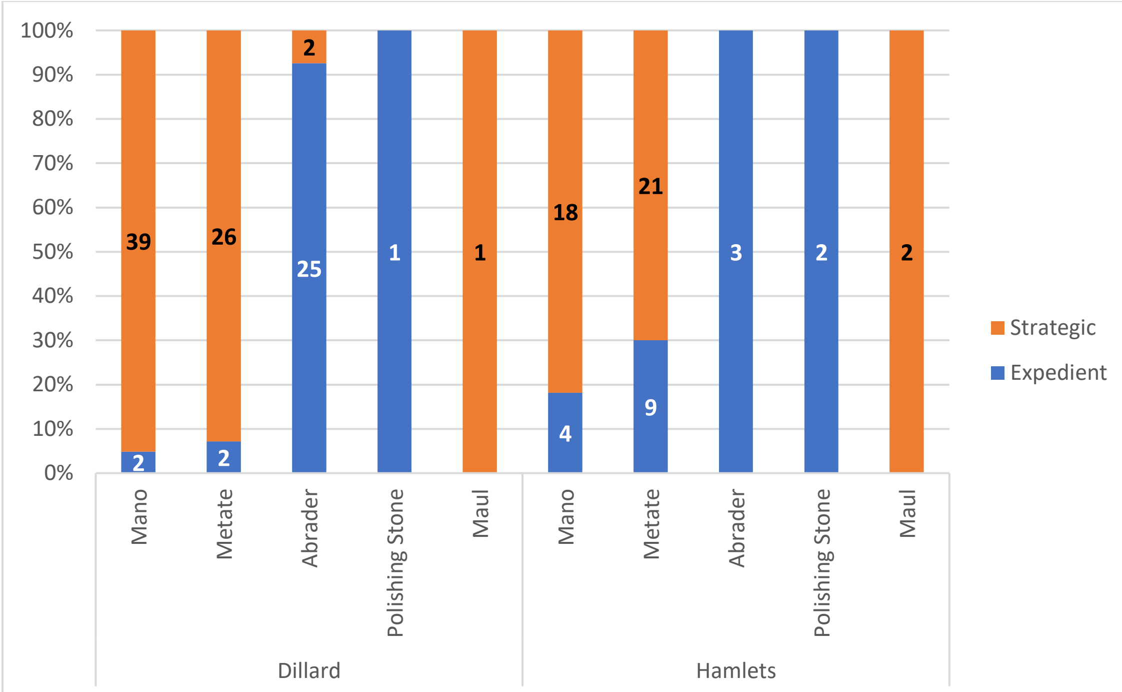


Figure 3.17. Design of Artifact Categories at The Dillard Site and The Hamlet Sites.

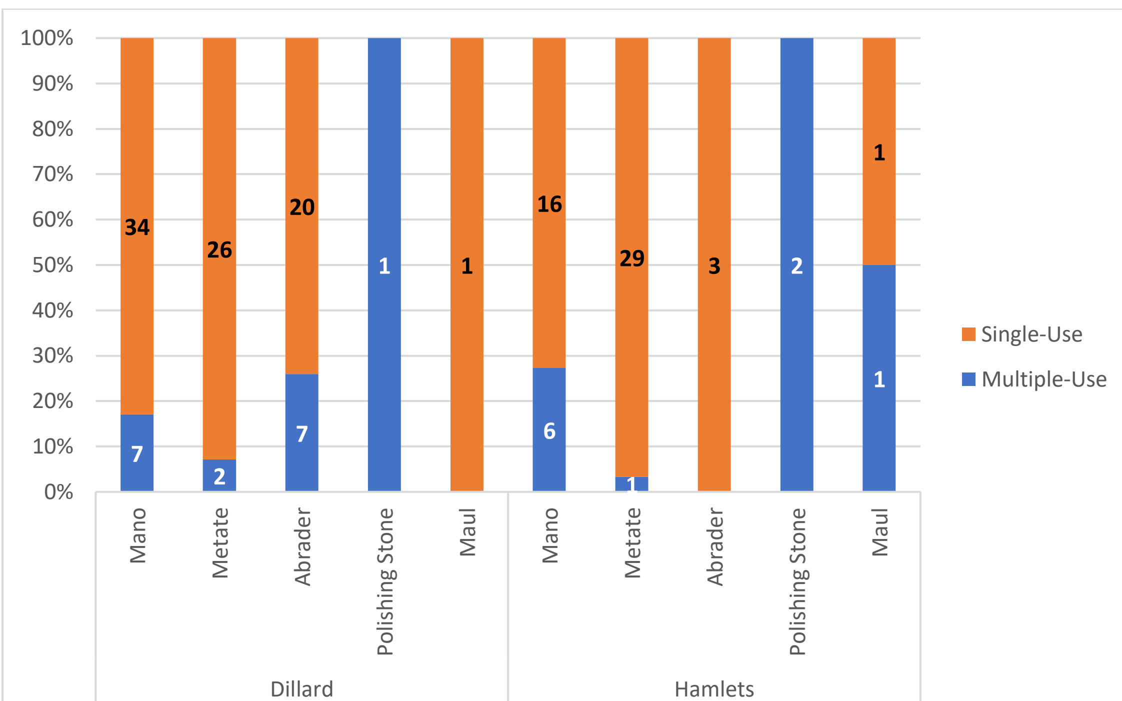


Figure 3.18. Use of Artifact Categories at The Dillard Site and The Hamlet Sites.

As previously discussed, the lithic materials used for the tools in this study mostly had fine granularity. Figure 3.19 indicates that coarser materials were particularly preferred for some artifact types. Manos at both the Dillard site and the hamlets were made from fine, medium, and coarse materials, though there was a noticeably higher percent of medium and coarse material at the Dillard site, 29% (n=12) and 7% (n=3), respectively. Abraders at the Dillard site also were much more likely to be made from medium or coarse material, but again, there were ten times as many abraders than at the hamlets. Both polishing stones and mauls had a higher frequency of medium and coarse materials at the hamlet sites, but likely insignificantly, since there were few artifacts of those types.

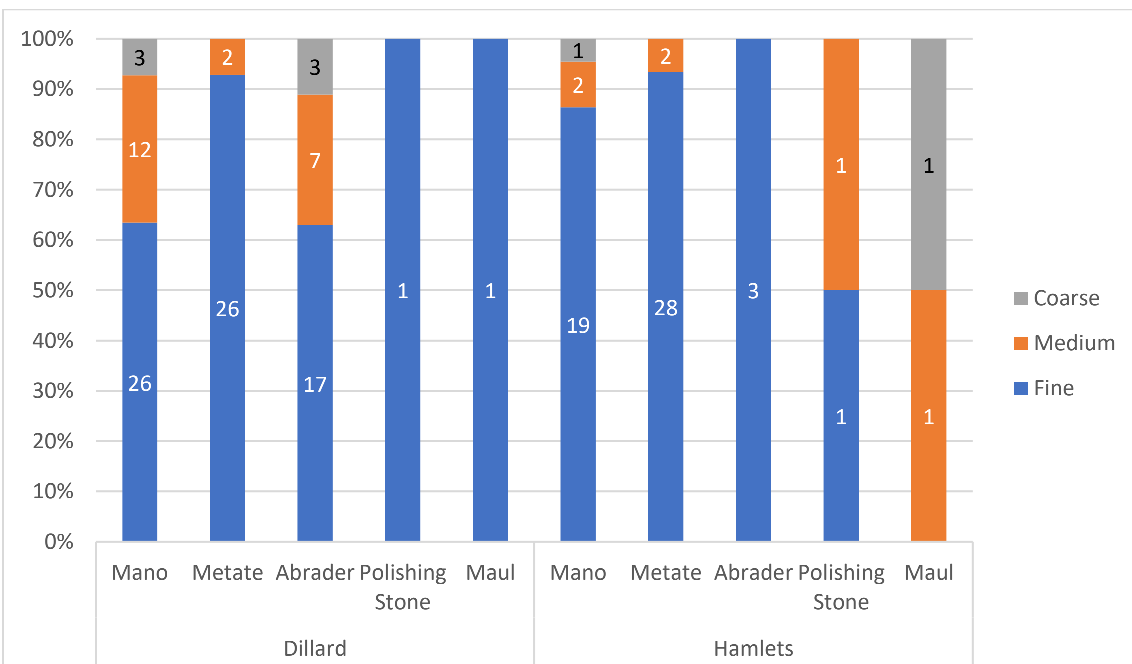


Figure 3.19. Granularity by Artifact Type at The Dillard Site and The Hamlet Sites.

Figure 3.20 illustrates the number of ground surfaces on each type of artifact. Manos are used on two sides more frequently at the hamlets than at the Dillard site. Metates, however, are almost exclusively used on one surface at the hamlets (87%), while they were frequently used on two, and sometimes three surfaces at the Dillard site (32% and 7%, respectively). Abraders at the Dillard site were mostly used on one surface, with fewer artifacts having two surfaces, while those from the hamlets exclusively had one grinding surface. Both polishing stones from the hamlet sites were used on two surfaces and the only polishing stone found at the Dillard site was used on just one surface.

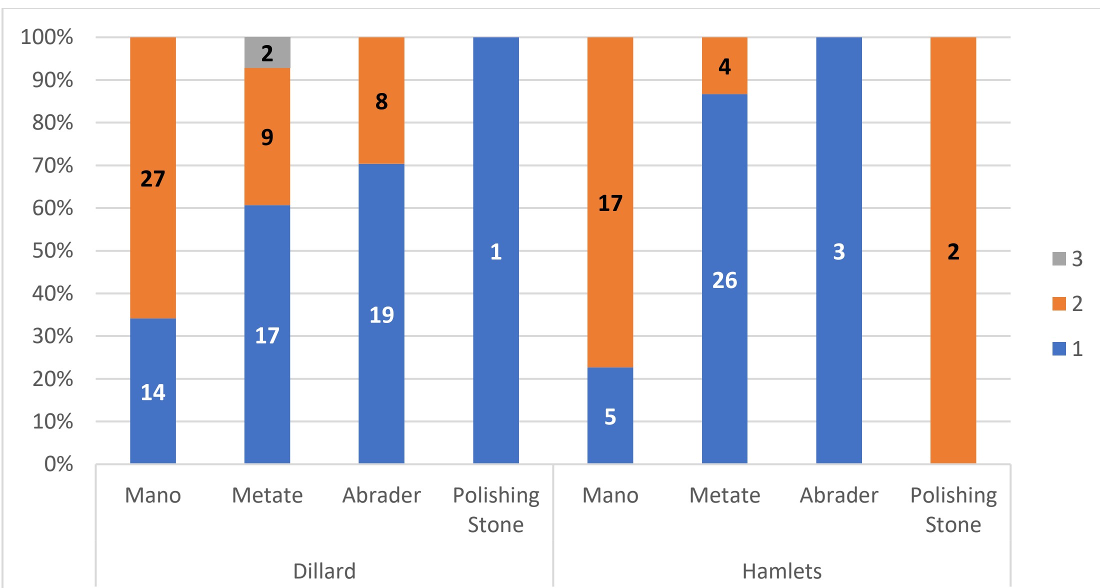


Figure 3.20. Number of Ground Surfaces for Artifact Types at The Dillard Site and The Hamlet Sites.

There are nine artifacts with visible pigment, five of which were from the Dillard site and four from the hamlets. Specifically, artifacts from the Dillard site consisted of an abrader with an unspecified color pigment, a polishing stone with red pigment, and three two-hand manos with red, yellowish red, and black pigment, respectively. One abrader with an unspecified color of pigment was from Mueller Little House (5MT10631) and three slab metates (with dark reddish brown to red, dark reddish brown, and reddish yellow pigment, respectively) were from Ridgeline (5MT10711).

Without further use wear analysis, and without analysis using a microscope, it is difficult to interpret these findings. However, the Dillard site has a higher number of artifacts with visible pigment than any other site, so it is reasonable to assume that more pigment processing took place there. Three slab metates from the Ridgeline site also likely indicate significant pigment processing. As previously mentioned, the color of the pigments indicates that the ground products that left the traces of pigments were likely for pottery or body decoration, rather than from clay or charcoal. They additionally confirm that two-hand manos and slab metates were used for tasks other than processing maize and other foods.

		The Dillard Site			**The Hamlets**	
Munsell Color	**Color**	**Abrader**	**Polishing Stone**	**Two-Hand Mano**	**Abrader**	**Slab Metate**
10R 4/6	Red	0	1	0	0	0
10R 4/8	Red	0	0	1	0	0
2.5YR 3/4 to 5/8	Dark reddish brown to red	0	0	0	0	1
2.5YR 2.5/3	Dark reddish brown	0	0	0	0	1
5YR 5/6	Yellowish red	0	0	1	0	0
7.5YR 6/8	Reddish yellow	0	0	0	0	1
GLEY 2.5/N	Black	0	0	1	0	0
(Blank)		1	0	0	1	0
Total		1	1	3	1	3

Table 3.8. Pigment on Artifacts from The Dillard Site and The Hamlet Sites.

Manos

As shown in Figure 3.21, there were nearly twice as many manos at the Dillard site (n=41) as at the hamlet sites (n=22). However, manos account for a smaller portion of the total artifact assemblage from Dillard, using grayware as a representative. The ratio of the count of manos to grayware weight is only 0.0005 at the Dillard site, compared to 0.0012 at the hamlets. Additionally, a higher percent of manos were unable to be typed at Dillard (39% compared to 23%). Excluding these untyped manos, the Dillard site had a much more even number of one-hand and two-hand manos (n=11 and n=14, respectively). The hamlets had almost twice as many two-hand manos as one-hand manos (n=11 and n=6, respectively).

Both mano types from the hamlet sites are larger than their counterparts from the Dillard site, for almost every dimension. As shown in Table 3.9, one-hand manos from the hamlets are 62% heavier, 22% longer, 7.5% wider, and 29% thicker than those from the Dillard site. Their first and second grinding surfaces are 17% and 18% larger, respectively. Two-hand manos are much more comparable: the hamlets' manos are only 3% heavier, and 4% longer, while the Dillard site's two-hand manos are 1% wider, and 9% thicker. Area of the first grinding surface was about 3% larger for the Hamlets' two-hand manos, while the Dillard site manos' second grinding surface was about 23% larger.

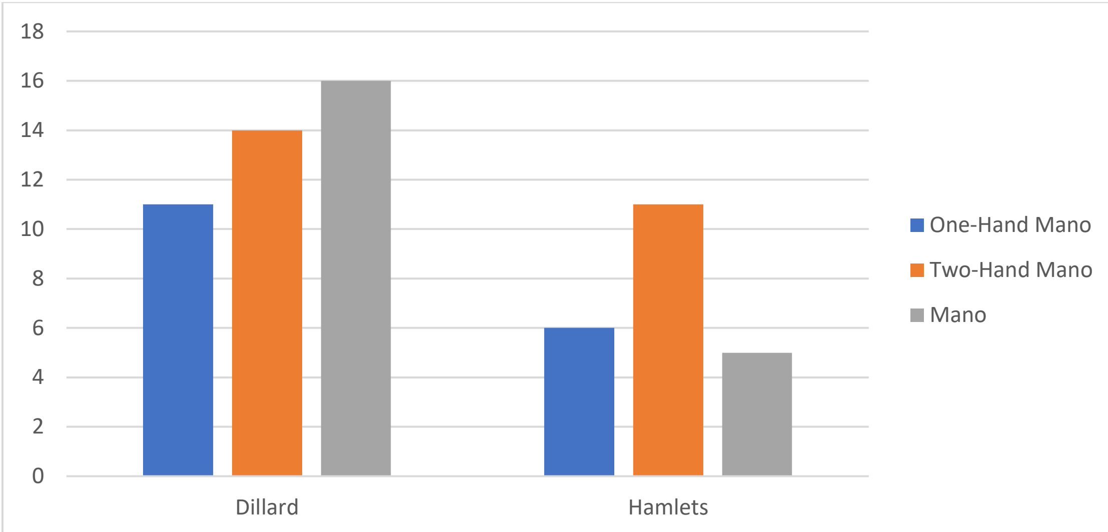


Figure 3.21. Counts of Mano Types at The Dillard Site and The Hamlet Sites.

Variable	**Dillard One-Hand Manos**	**Hamlets One-Hand Manos**	**Dillard Two-Hand Manos**	**Hamlets Two-Hand Manos**
Weight (g)	750.2	1218.2	1257.7	1292.1
Length (cm)	11.6	14.2	18.3	19
Width	9.3	10	11.6	11.5
Thickness	4.8	6.2	3.8	3.5
Surface 1 Area	78.6	91.9	192.7	198
Surface 2 Area	77.4	91.7	169.8	138.4

Table 3.9. Dimensions of Mano Types at The Dillard Site and The Hamlet Sites.

Figure 3.22 plots the efficiency of each mano type for the Dillard site and the hamlet sites. Efficiency considers both grinding surface area and weight, which together determine a tool’s grinding potential (Adams 2014). One-hand manos from the hamlets are clearly more efficient than those from the Dillard site, but this is mostly due to their heavier weights. The two-hand manos are also more efficient on average due to their weights, but the difference is less distinct. I anticipated that efficiency would be more important at the Dillard site because of its larger population. However, efficiency may be more important at the hamlet sites because there were fewer people residing at them, meaning less time could be spent grinding because each person had more responsibilities.

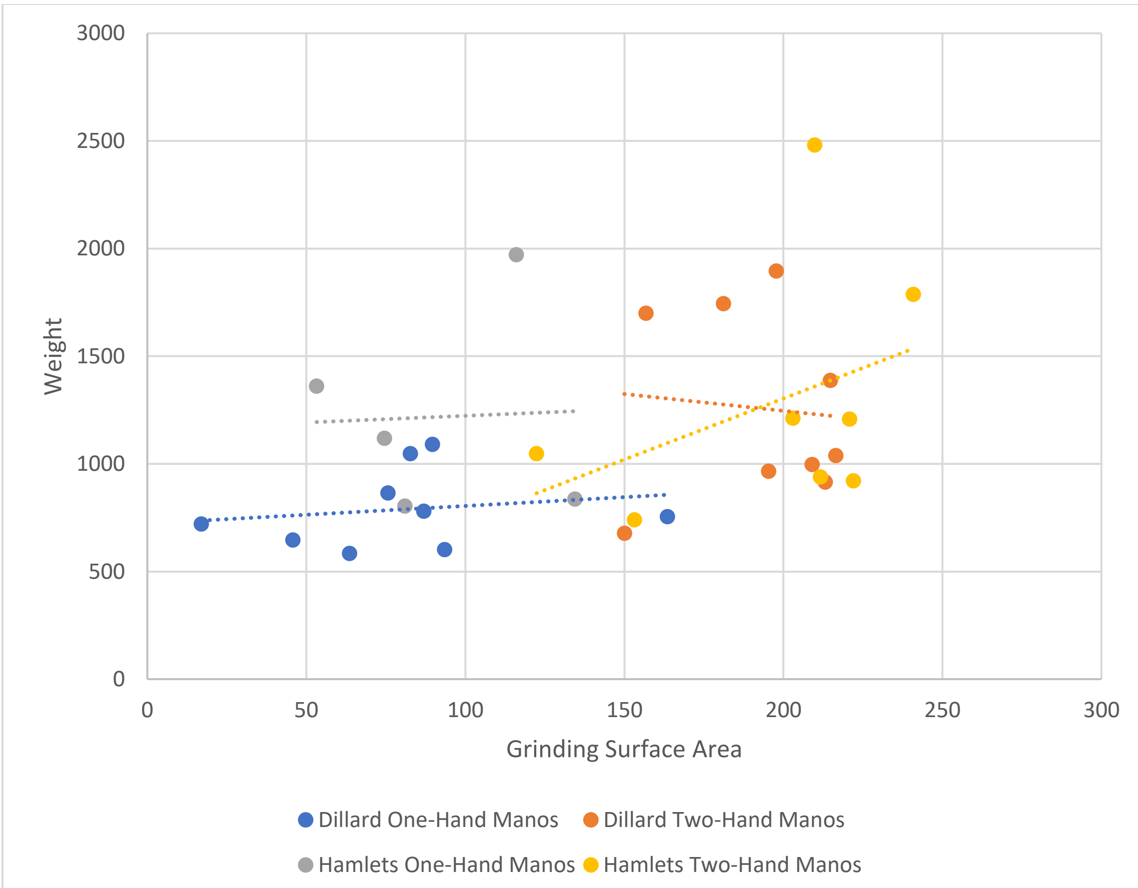


Figure 3.22. Efficiency of Mano Types at The Dillard Site and The Hamlet Sites (Dillard one-hand n=9, hamlets one-hand n=5, Dillard two-hand n=9, hamlets two-hand n=8).

Because magnified use-wear analysis was not conducted as part of this study, analyzing striation patterns on manos and metates may be the best method for interpreting their actual uses within the scope of this study. Figure 3.23 separates visible striation patterns of one-hand and two-hand manos from the Dillard site and the hamlet sites, revealing distinct differences in their use patterns. One-hand and two-hand manos from the Dillard site have similar percentages of each striation pattern. Both have mostly linear striations, with lesser amounts of multi-directional striations and even fewer without visible striations. At the hamlet sites, however, one-hand manos had mostly multi-directional striations, while two-hand manos only had linear striations, or did not have any visible striations.

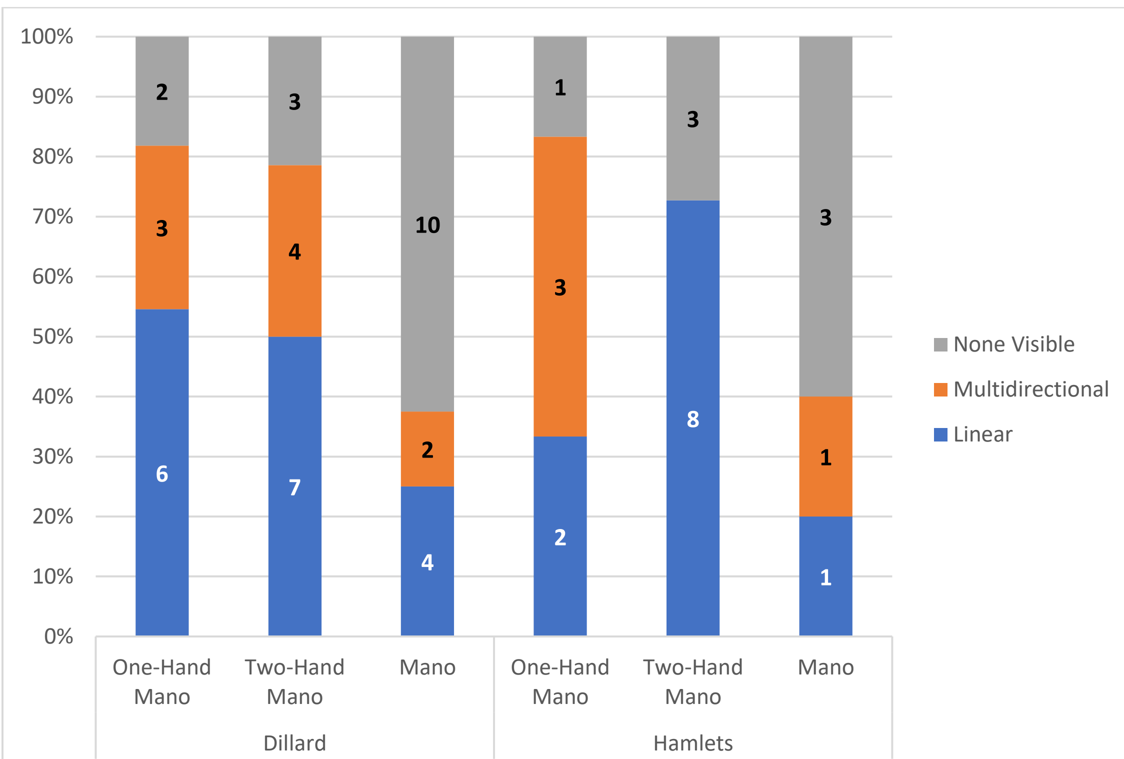


Figure 3.23. Striation Pattern of Mano Types at The Dillard Site and The Hamlet Sites.

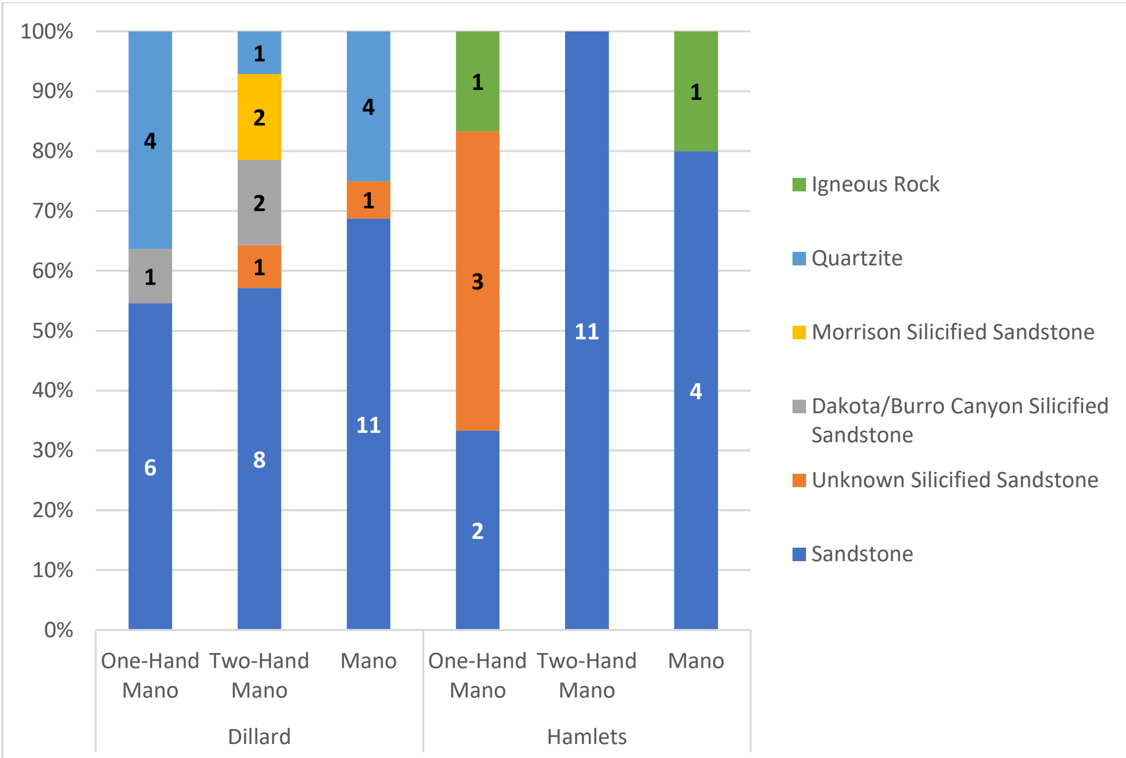


Figure 3.24. Material Types of Mano Types at The Dillard Site and The Hamlet Sites.

Figure 3.24 shows a strict use of sandstone for two-hand manos at the hamlet sites, while both types of manos have a greater variety of material types at the Dillard site. This shows a clear distinction between one-hand and two-hand manos at the hamlets that is not present at the Dillard site. Manos from the Dillard site also exhibit a wider variety in granularities than those from the hamlets (Figure 3.25). At the hamlets, two-hand manos are exclusively fine-grained, with only minimal numbers of medium or coarse-grained manos. This may indicate a stricter preference at the hamlet sites for fine-grained material, a need for different granularities of manos at the Dillard site, or a combination of the two scenarios.

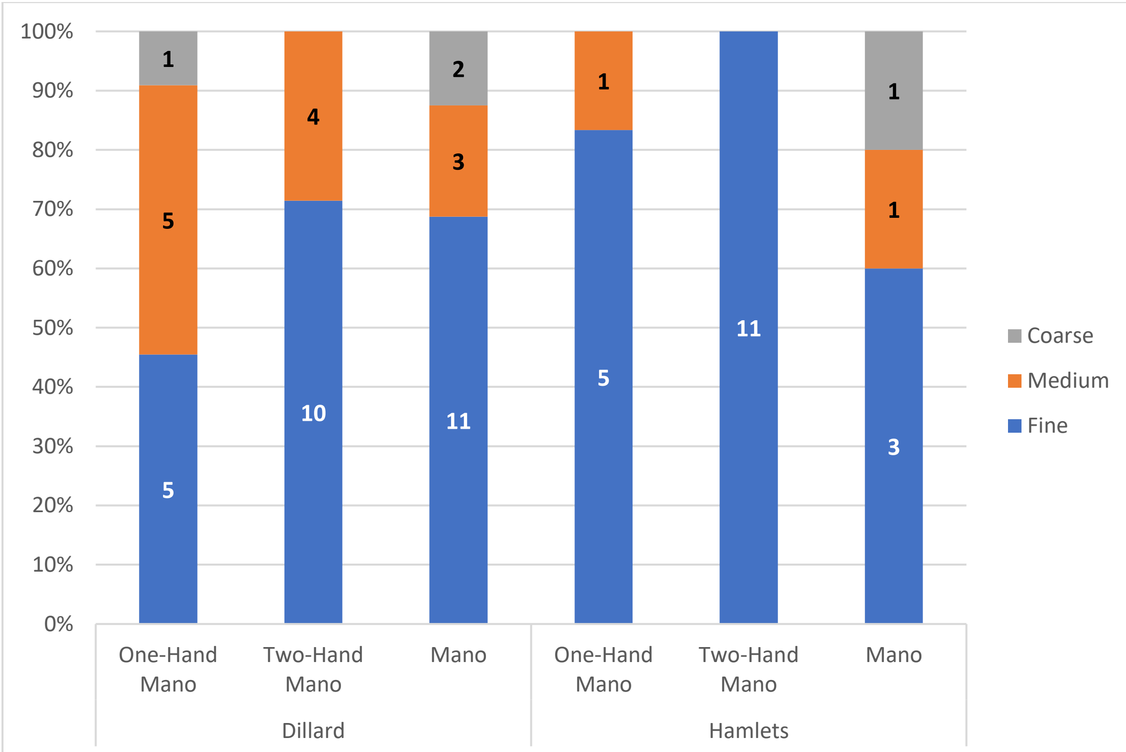


Figure 3.25. Granularities of Mano Types at The Dillard Site and The Hamlet Sites.

Figure 3.26 depicts the differences between design and use for mano types at the Dillard site and the hamlet sites. Manos of both types from the Dillard site are overwhelmingly strategically made and single-use. One two-hand mano is strategic and multiple-use, while 18% of one-hand manos are strategic and multiple-use, and 18% are expedient and multiple-use. At the hamlet sites, however, one-hand manos are mostly expedient tools, with equal numbers of both single-use and multiple-use tools. This, again, shows that one-hand and two-hand manos are more differentiated at the hamlet sites, while they are less differentiated but overall more formalized tools at Dillard.

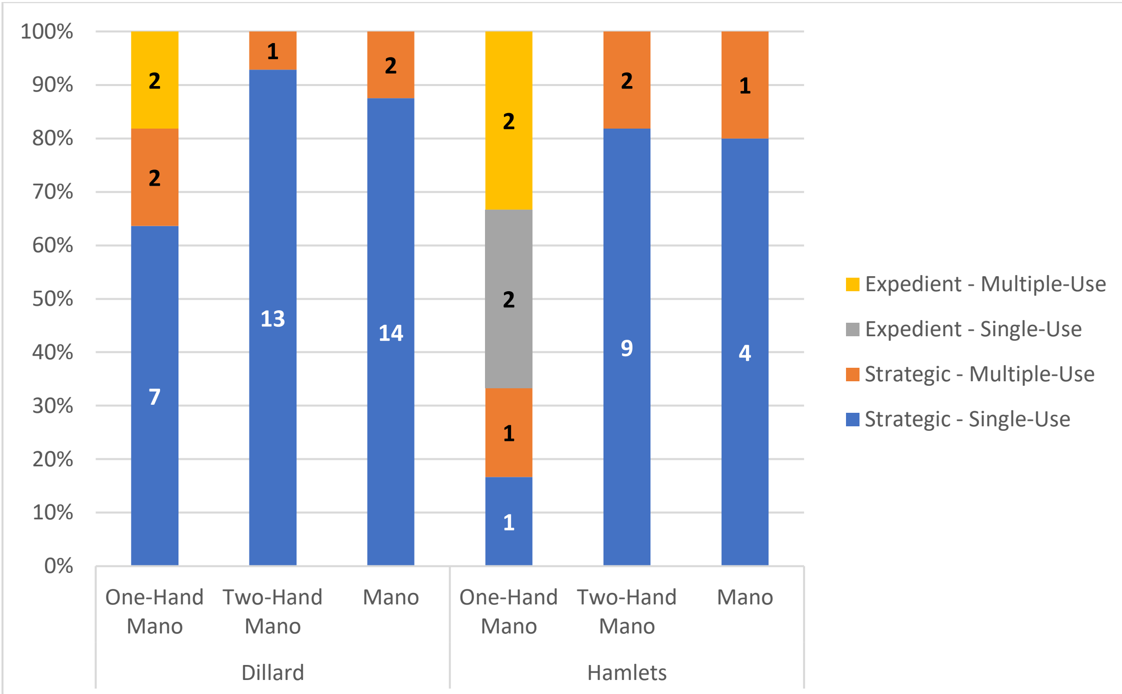


Figure 3.26. Design and Use of Mano Types at The Dillard Site and The Hamlet Sites.

One-hand and two-hand manos were worn to different extents at the Dillard site and the hamlets. Figure 3.27 shows that manos of all types at the Dillard site are much more heavily worn than those at the hamlets. Two-hand manos also have a much higher rate of heavy wear compared to one-hand manos at the Dillard site, while degree of wear was more comparable between mano types for the hamlet sites. Additionally, as Figure 3.28 indicates, two-hand manos in both cases were more likely to be pecked to increase coarseness. However, two-hand manos from the Dillard site were much more frequently pecked than their one-hand counterparts, while the difference was less striking between the mano types at the hamlet sites. Both one-hand and two-hand manos at the Dillard site were pecked more frequently than their type counterparts at the hamlet sites, which follows based on the significantly higher use wear on all types of manos at the Dillard site. While this may represent a more intensive use of tools, it may also result from longer occupation of the Dillard site and thus the longer period that tools were used.

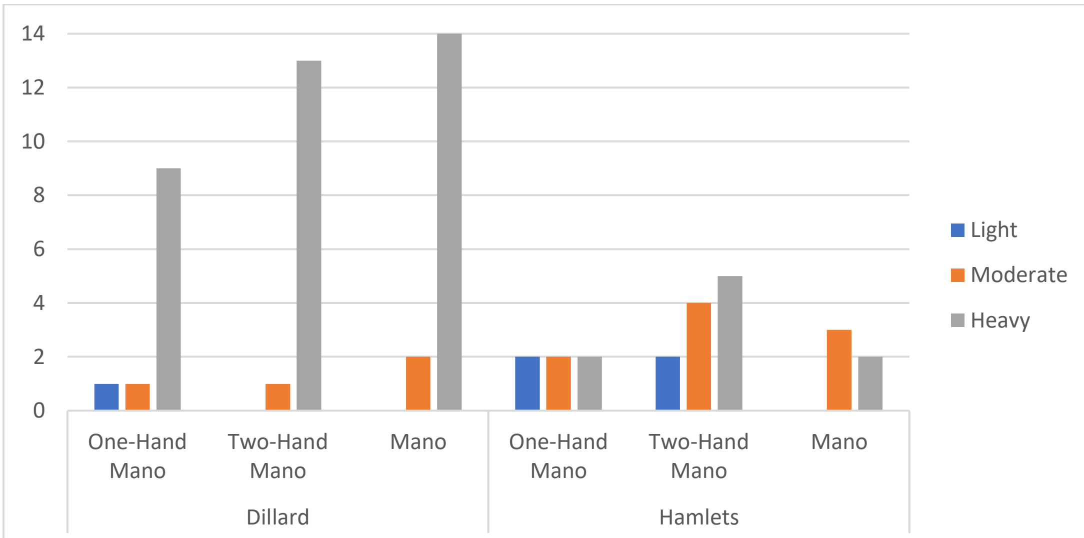


Figure 3.27. Degree of Wear of Mano Types at The Dillard Site and The Hamlet Sites.

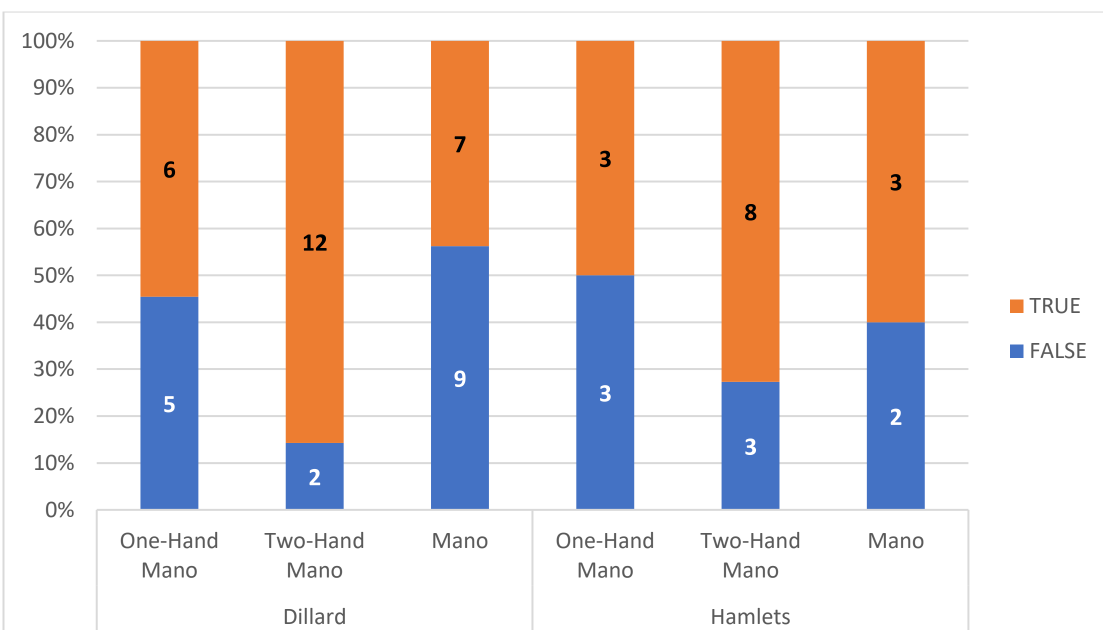


Figure 3.28. Increased Coarseness for Manos at The Dillard Site and The Hamlet Sites.

Mano profiles or cross-sections provide another way to examine maintenance strategies of manos. Tabular manos were present in both mano types from the Dillard site, but in higher numbers for two-hand manos. At the hamlets, only two-hand manos had tabular cross-sections, but they were 82% of the assemblage. Wedge manos were relatively uncommon but had low numbers in Dillard two-hand manos, and slightly higher percentages of both types of manos from the hamlets. Domed manos were only represented in the Dillard site assemblage, comprising 18% of the one-hand manos and 36% of the two-hand manos. Cobble cross-sections were only present on one-hand manos but represent significant portions from both Dillard and the hamlets. While some cross-section types are restricted to a mano type, some are used only at either the Dillard site or the hamlets, indicating distinct wear management strategies and types of tool blanks or pre-forms from different communities.

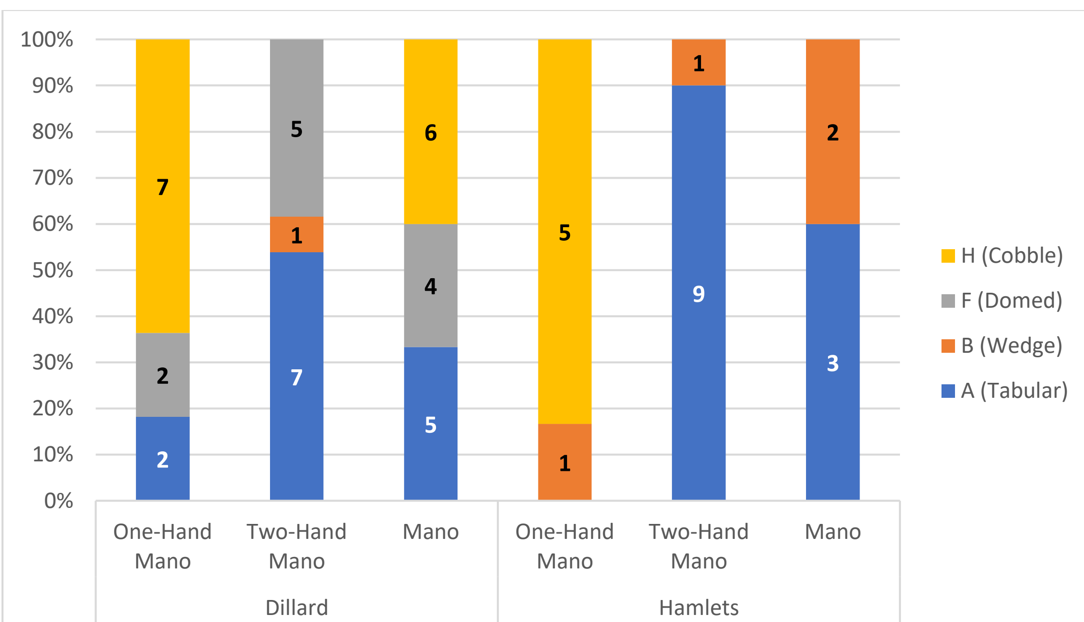


Figure 3.29. Mano Cross-Section at The Dillard Site and The Hamlet Sites.

Metates

There are more metates at the hamlet sites (n=30) than at the Dillard site (n=28), which is unique for any artifact category. As Figure 3.30 indicates, there are significantly more slab metates present at the hamlet sites than any other metate type (n=18). There are fewer trough metates, and even fewer basin metates. At the Dillard site, slab metates still predominate (n=11), but trough and basin metates have equally low counts (n=2). However, there were many more untyped metates at the Dillard site (n=13, 46%) than at the hamlet sites (n=6, 20%). These metates were broken past the point of type identification, likely indicating heavy use and discard.

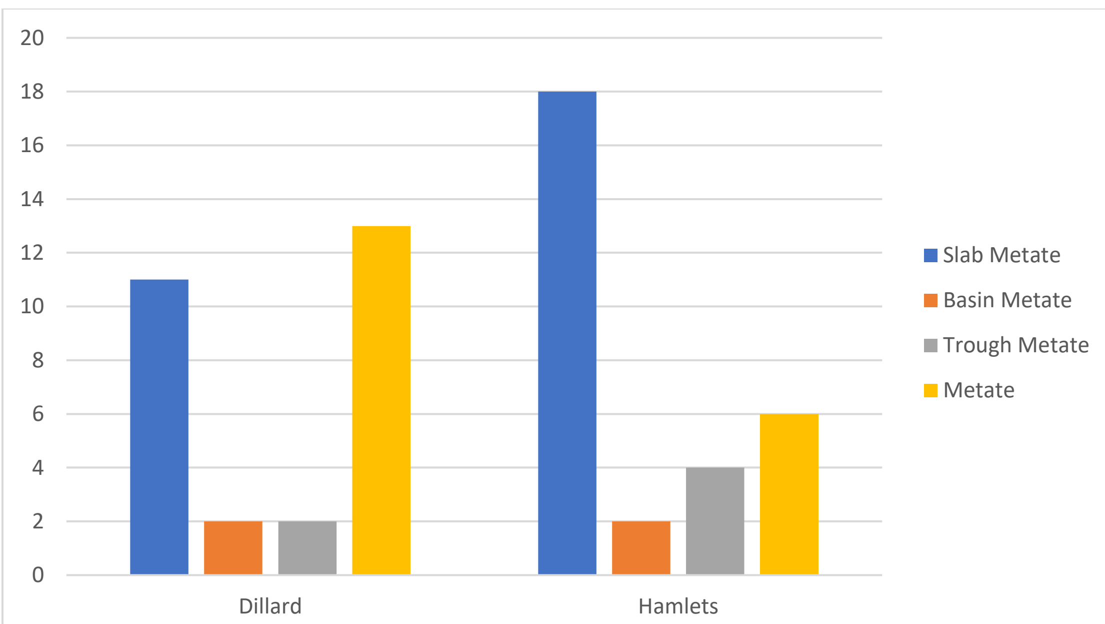


Figure 3.30. Metate Types at The Dillard Site and The Hamlet Sites.

Because there were so few basin and trough metates, basic dimensions are difficult to compare between the Dillard site and the hamlet sites. Table 3.10 lists measurements for basic variables, though only the slab metate categories contained more than one complete artifact; the average dimensions of these are listed. The basin metates from the Dillard site were both fragments, so measurements are not representative of the actual artifact size and are excluded. The dimensions for basin metates from the hamlet sites are from the one complete artifact in that category. For trough metates from both the Dillard site and the hamlets, measurements are taken from one incomplete metate, which was the most representative artifact available for the category.

Slab metates from the Dillard site are larger than those from the hamlets in all dimensions apart from thickness: they are 27% heavier, 62% longer, 52% wider, and have grinding surfaces 39% larger, though they are only 52% as thick, which likely results from heavier or more extensive use. The one basin metate from the hamlets roughly compares to the size of slab metates. However, even though the basin metate is slightly larger for all dimensions, its grinding surface is only 60% of the size of the slab metates' grinding surfaces. Basin metates' smaller and thus less efficient grinding surfaces may partially explain their relative scarcity in the assemblage. Though incomplete, the trough metates are much larger for all dimensions than any of the other types of complete metates. These were highly efficient for processing large amounts of ground product but were much less versatile than the predominating slab metates, restricting the grinding motion of the user and requiring a compatible mano to maximize their efficiency. Slab metates far outnumber other categories, likely because they were efficient and versatile.

Variable	**Dillard Slab Metates**	**Hamlets Slab Metates**	**Hamlets Basin Metate**	**Dillard Trough Metate**	**Hamlets Trough Metate**
Count	2	3	1	1	1
Weight (kg)	15.5	12.2	10.8	26.4	17.2
Length (cm)	53	32.7	36	61	61
Width	35.5	23.3	32.3	42	46.5
Thickness	5.3	10.1	12.5	9	6.5
Trough Length	0	0	0	42	46
Trough Width	0	0	0	18	25
Trough Depth	0	0	0	3.5	4.5
Ground Surface Area	905.5	650.9	390	756	1150

Table 3.10. Dimensions of Metate Types from The Dillard Site and The Hamlet Sites.

Metates were overwhelmingly made of locally available sandstone at both the Dillard site and the hamlet sites (Figure 3.31), likely because lithic material large enough to make into metates is heavy and difficult to carry more than a short distance. Slab metates have a slightly higher variation overall, and though that may be influenced by their overall higher counts, there is no variation in the untyped metate category, suggesting that variation is restricted to the slab type. The only variation in material at the Dillard site are one slab and one basin metate, both made of Morrison silicified sandstone. For the hamlet sites, variation consists of one Morrison silicified sandstone metate and one Dakota/Burro Canyon silicified sandstone metate, both slab types. Sandstone was highly effective and immediately locally available, and likely due to these reasons, residents of the sites chose to utilize it most often.

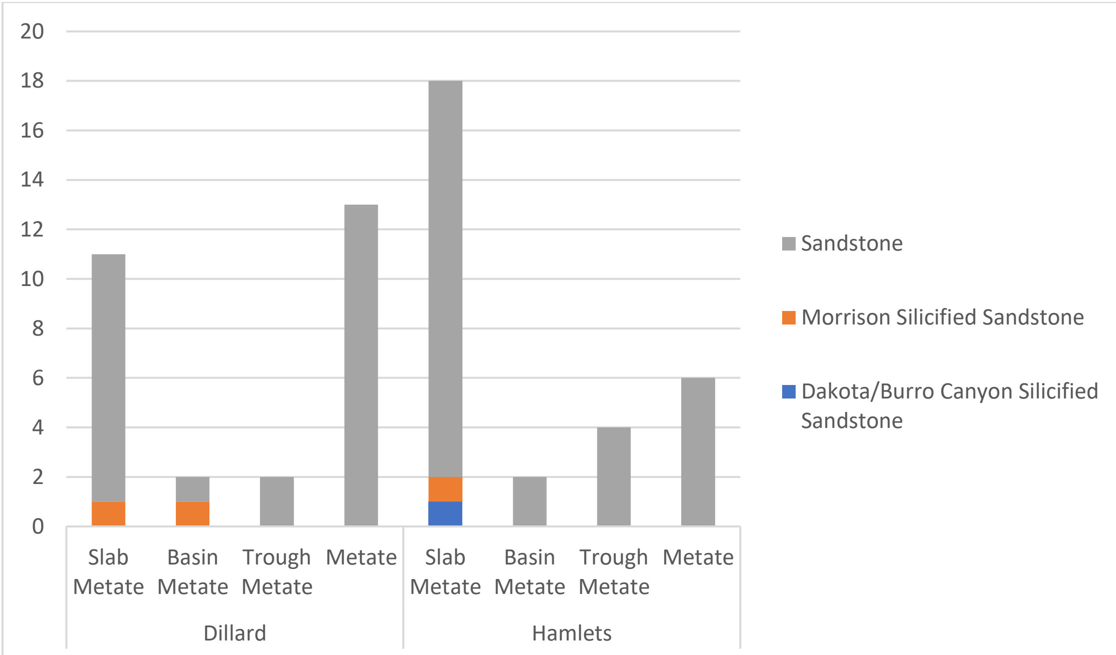


Figure 3.31. Material of Metate Types at The Dillard Site and The Hamlet Sites.

Comparing striation patterns left on metates from the Dillard site and the hamlet sites reveals, at least broadly, differences in the ways they were used (Figure 3.32). Slab metates from the Dillard site, when striations were visible, had only multidirectional striations, while slab metates from the hamlet sites had more linear striations than multidirectional. Basin metates had both striation patterns at the Dillard site, but only multidirectional striations at the hamlet sites. Trough metates from the Dillard site had only linear striations, while those from the hamlets had linear and multidirectional striations. Basin and trough metates had much lower counts than slab metates, so the percentages of each striation pattern present may be less representative overall than those for slab metates. Overall, it seems that slab and trough metates had more restricted, specialized functions at the Dillard site, and a wider range of uses at the hamlet sites.

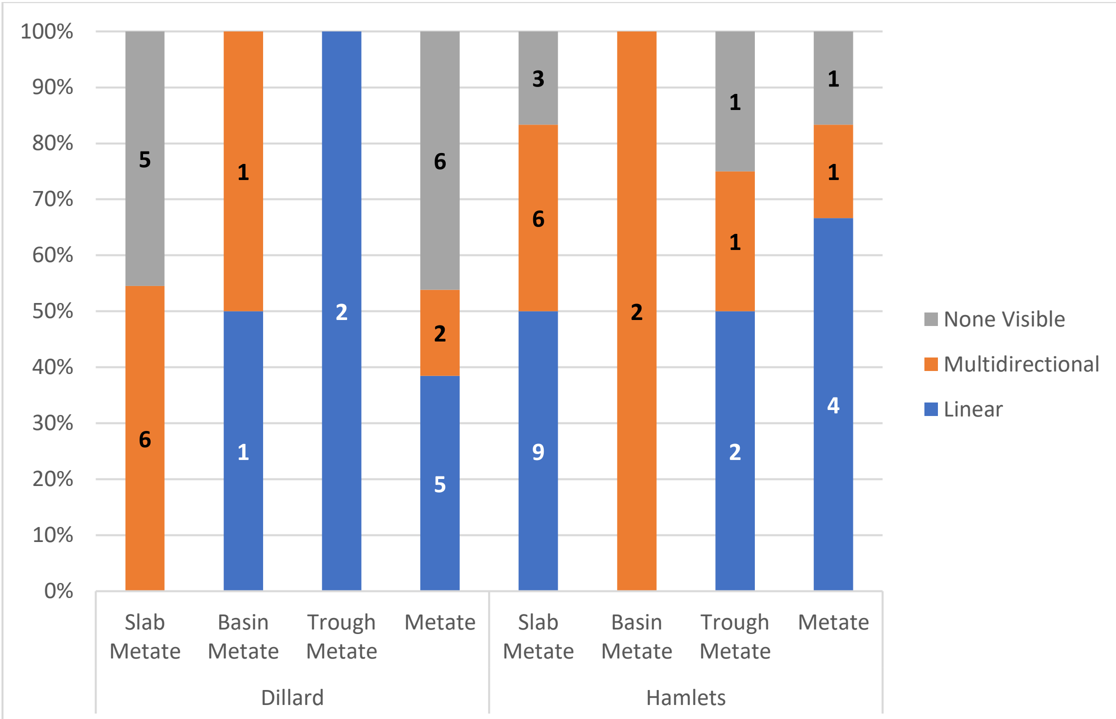


Figure 3.32. Striation Pattern of Metate Types at The Dillard Site and The Hamlet Sites.

Metates from both the Dillard site and the hamlet sites are overwhelmingly strategically designed (Figure 3.33). However, for all metate types, the Dillard site sample has a higher percentage of strategic design than the hamlet sites. Additionally, all metates were single-use, apart from three. These three consisted of one slab metate and one trough metate from the Dillard site, as well as one slab metate from the hamlet sites. This shows that metates overall were formal tools, created for a particular purpose and primarily used only for that purpose. However, residents of the hamlet sites more often considered an expedient tool to be sufficient for the task, while Dillard residents preferred to design their tools.

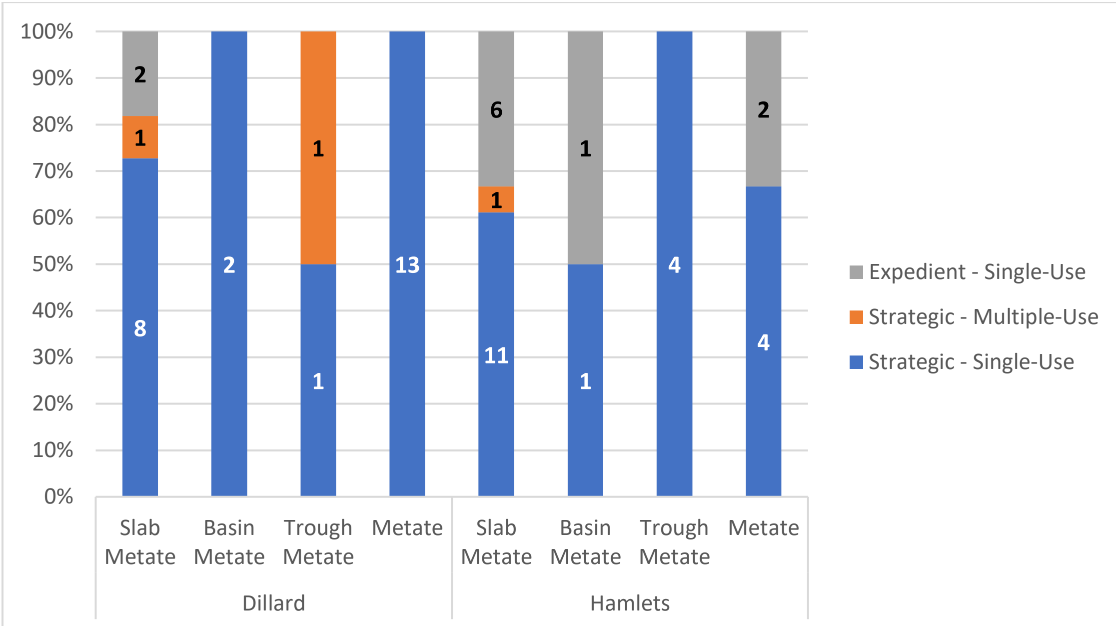


Figure 3.33. Design and Use of Metate Types at The Dillard Site and The Hamlet Sites.

Degree of wear, like the previously discussed analytic variables, is easier to interpret for slab metates than the other types, because the artifact counts are higher. Slab metates from the Dillard site were 36% lightly worn (n=4), 55% moderately worn (n=6), and 9% heavily worn (n=1). Slab metates from the hamlet sites were 22% lightly worn (n=4), 61% moderately worn (n=11), and 27% heavily worn (n=3), making the percentages of each degree of wear comparable to the Dillard site metates. The remaining metates from the Dillard site were moderately or heavily worn. The remainders from the hamlet site had lightly and moderately worn metates but were mostly heavily worn. Slab metates had the greatest variety of any metate type, perhaps because they were the most common.

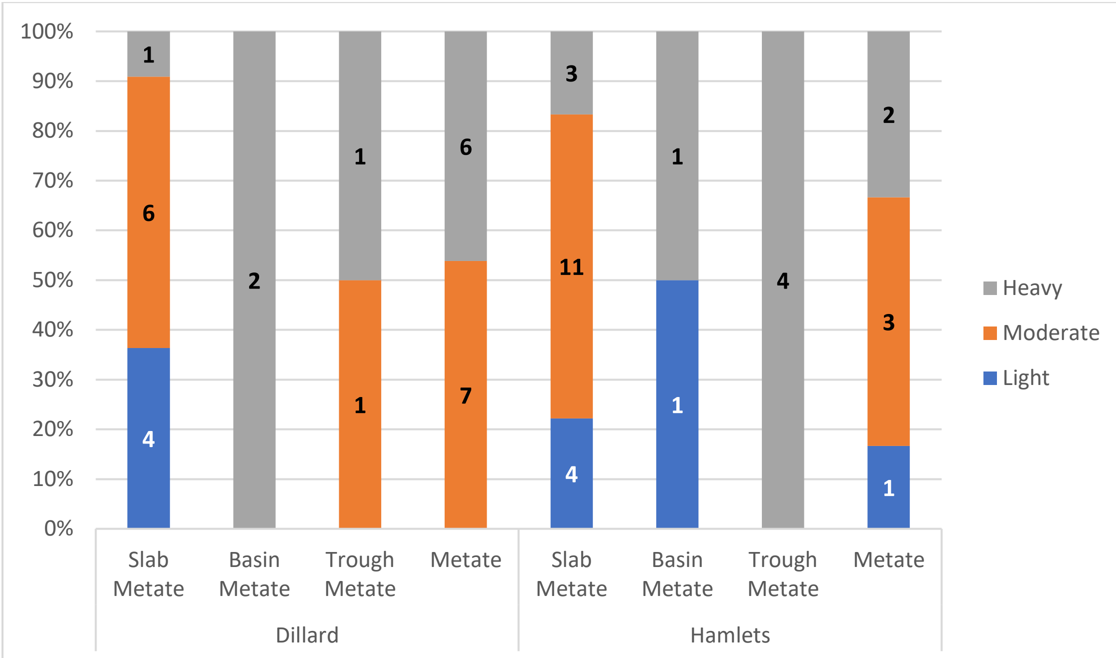


Figure 3.34. Degree of Wear of Metate Types at The Dillard Site and The Hamlet Sites.

Metates from the Dillard site were pecked to increase coarseness at almost the same rate as those from the hamlet sites (68% and 67%, respectively). However, slab metates at the hamlet sites were much more frequently pecked than those at the Dillard site. Both basin metates from the Dillard site were pecked, while the trough metates were split evenly. The opposite was true at the hamlet sites: basin metates were split evenly and all trough metates were pecked. The untyped metates from the Dillard site were most often pecked, while those from the hamlet sites were split evenly. There is clearly greater investment in keeping slab metates functioning efficiently, especially because they are the preferred metate type for both the Dillard site and the hamlet sites. However, if the untyped metates are the best representation of all the types combined, metates from the

Dillard site are much more likely to be pecked than not, while the hamlet sites' metates are evenly split.

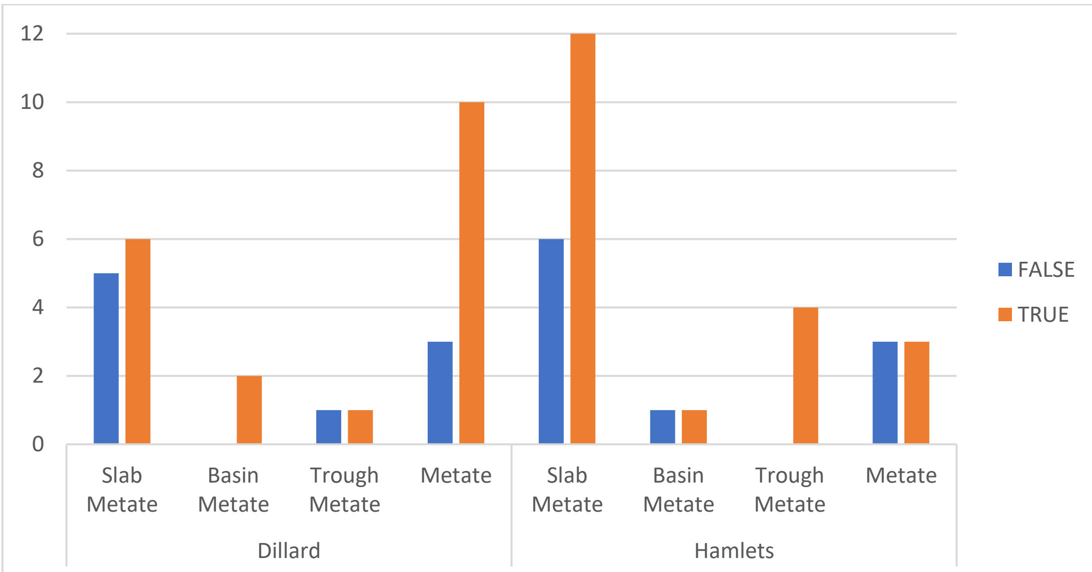


Figure 3.35. Increased Coarseness of Metate at The Dillard Site and The Hamlet Sites.

Abraders

Abraders were unevenly distributed between the Dillard site (n=27) and the hamlet sites (n=3). Three hamlet sites contained one abrader each: Mueller Little House (5MT10631), the Ridgeline site (5MT10711), and the Switchback site (5MT2032). This contrast suggests that abraders served a specialized function that was not common to the hamlet sites but was more important at the Dillard site. Abrading, whether stone or bone, seems to have taken place at a restricted number of sites, likely by a restricted number of individuals. Whereas manos and metates are common throughout all sites excavated in the Basketmaker Communities Project, abraders were not necessary to carry out community functions at all of the sites. Additionally, Table 3.11 shows that abraders from the Dillard site were larger in all dimensions than those from the hamlet sites. Abraders from the hamlet sites only had one grinding surface each, while five abraders from the Dillard site had two grinding surfaces. The mean of the primary grinding surfaces of the Dillard abraders was larger than that of the hamlets, however, their medians were more comparable, because the Dillard site had a larger outlier.

Variable	Mean		Median		Stand. Dev.		Min.		Max.		Count	
	D	H	D	H	D	H	D	H	D	H	D	H
Weight (g)	590.5	237.6	478.2	237.6	566.3	129.8	105	145.8	2,046.6	329.4	18	2
Length (cm)	10.8	9.5	10.5	9.5	3.3	2.6	6.2	7.6	16	11.3	18	2
Width	8.6	5.9	8.5	5.9	2.5	0.7	4.9	5.4	13	6.4	18	2
Thickness	5.4	3.3	3.1	3.3	7.9	0.9	1.2	2.6	36.1	3.9	18	2
Surface 1 Area	65.4	53.8	51.2	53.8	49.3	17.9	2.8	41.1	208	66.4	18	2
Surface 2 Area	60.7	0	14.9	0	33.3	0	27	0	105.1	0	5	0

Table 3.11. Average Dimensions of Abraders at The Dillard Site and The Hamlet Sites.

All 30 abraders in this study were made of sandstone, making abraders the most uniform artifact category in terms of material. This uniformity indicates that Ancestral Pueblo occupants of the Dillard site and the hamlet sites likely conceived of abraders as the same category of object, one that was made only out of immediately available material. Abraders from the Dillard site were split roughly evenly between having linear and multi-directional striations and no striations. One abrader from the hamlet sites had linear striations, and two did not have visible striations, making interpretation difficult. Additionally, as shown in Figure 3.36, expedient, single-use tools predominated at the

Dillard site (67%) and comprised all three abraders from the hamlet sites. The remainder at the Dillard site were expedient, multiple-use tools (26%), and only two were strategic, single-use tools (7%).

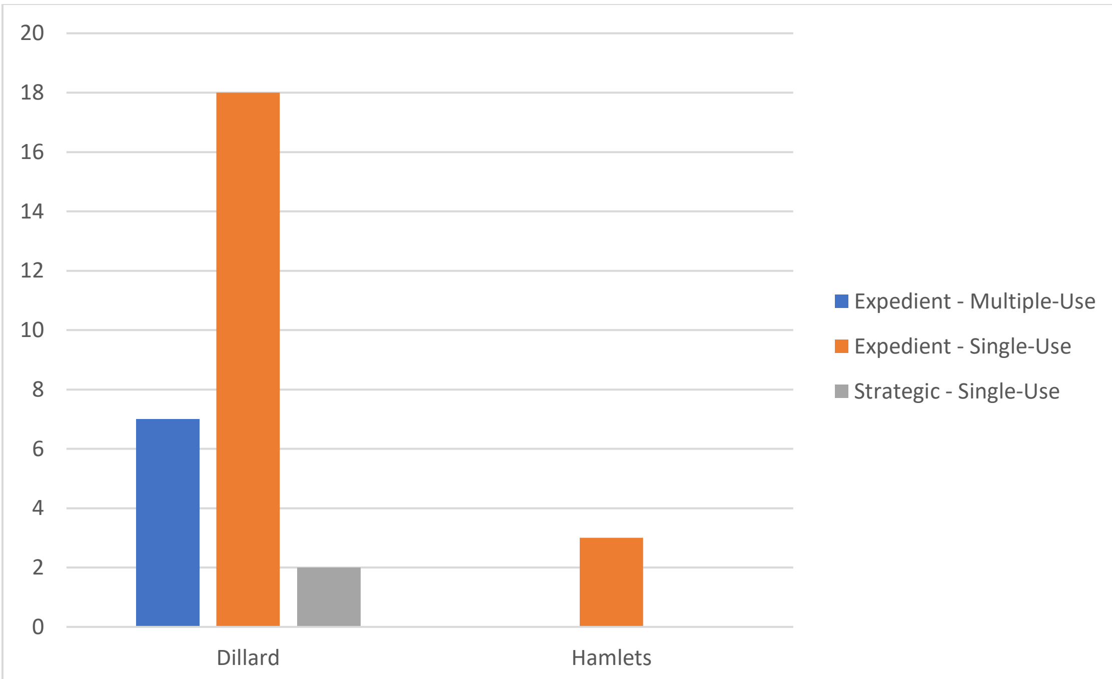


Figure 3.36. Design and Use of Abraders at The Dillard Site and The Hamlet Sites.

Abraders from the Dillard site mostly had moderate wear (63%), with smaller numbers heavily worn (22%) and lightly worn (15%). Degree of wear was split evenly between the three hamlets abraders. While there is investment in particular tools evident in the presence of heavy and moderate wear, abraders are certainly less worn than manos and metates. They are not used to perform the same kinds of large-scale food processing, so likely wear more slowly. The amount of time spent using the abrader required to achieve heavy wear would likely depend on the nature of the material being abraded.

Furthermore, only seven abraders (26%) at the Dillard site had been pecked to increase coarseness, and none were pecked of the hamlet sites assemblage. Pecking is not common to abraders (Ortman, et al. 2005) so the low numbers are unsurprising, but the presence of pecked abraders at the Dillard site may indicate a higher value of those tools.

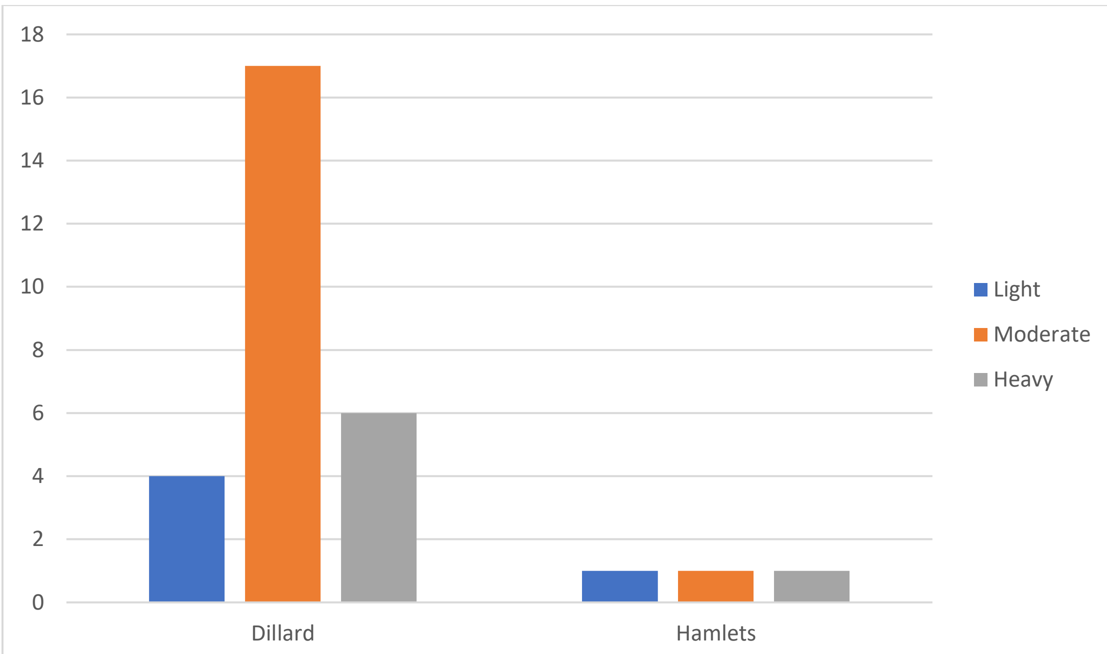


Figure 3.37. Degree of Wear for Abraders at The Dillard Site and The Hamlet Sites.

Overall, most abraders did not have any grooves. There were 21 abraders without grooves at the Dillard site, three abraders with one groove each, and one abrader each with two, three and four grooves. Abraders from the hamlet sites included two without grooves and one with five grooves. The Dillard abraders show more variety, likely in part due to the larger assemblage, however, the five-grooved abrader from the hamlet sites may be an extensively used tool, the result of less intensive grinding over a longer period, but with one tool being put to good use. Though abraders were only made of immediately available material, and were usually expediently designed tools, they were specialized tools that most hamlet sites in the project area did not use. Abraders were more common at the Dillard site, more heavily worn, more likely to be strategically designed, and have increased coarseness, all indicating the higher prevalence of abrading tasks.

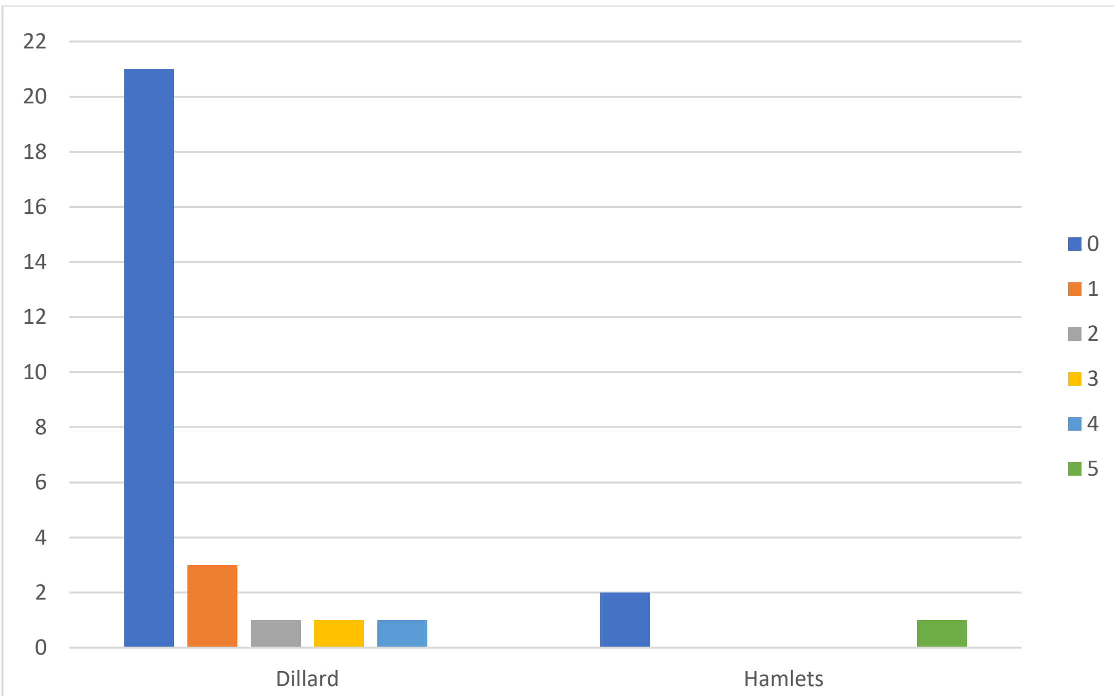


Figure 3.38. Counts of Grooves on Abraders at The Dillard Site and The Hamlet Sites.

Additional Artifact Types

Even with the low counts of the remaining artifact categories, Figure 3.39 shows there are differences between the assemblages from the Dillard site and the hamlet sites. The artifact categories only found at the Dillard site (pestle and stone mortar) are made exclusively of sandstone. The polishing stone from Dillard is made of igneous rock, while the two from the hamlet sites are made of quartzite and unknown silicified sandstone. The maul from the Dillard site is made of Morrison mudstone, while those from the hamlets are both made of igneous rock.

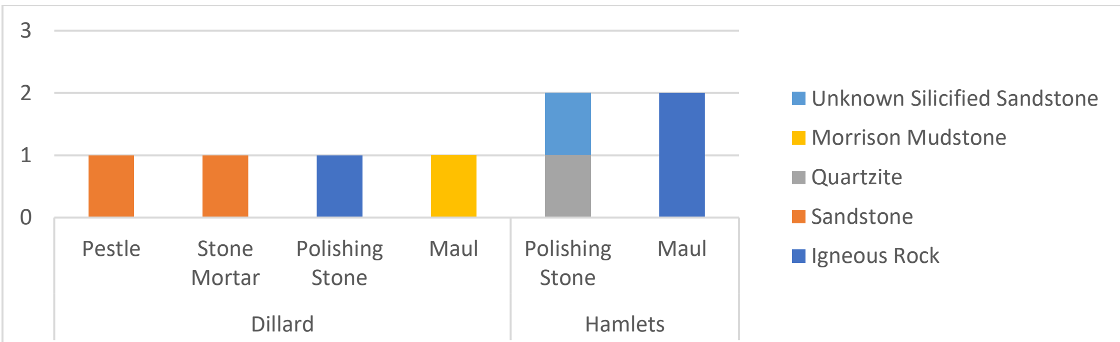


Figure 3.39. Material Types of Additional Artifact Categories at The Dillard Site and The Hamlet Sites.

Table 3.12 compares dimensions for polishing stones and mauls, the only two remaining artifact categories present at both the Dillard site and the hamlet sites. The polishing stone from the Dillard site is significantly heavier and larger than the two from the hamlet sites, with a primary use surface over five times the size and a secondary grinding surface nearly five times the size. The only maul from the Dillard site was complete, however of the two from the hamlet sites, one was incomplete and used for comparison, while the other, fragmented maul was left out. Despite being incomplete, the maul from the hamlets is both heavier and larger than the Dillard site maul. The pestle and stone mortar present at the Dillard site indicate a broader variety of processing techniques, likely for different methods of food preparation, which were not utilized at the hamlet sites. Polishing stones and mauls were present at both the Dillard site and the hamlet sites and can be classified as construction or house maintenance tools. Mauls were blunt and heavy, often used for pounding posts, while the polishing stones were perhaps used for smoothing floors and walls.

Variable	Dillard Polishing Stone	Hamlets Polishing Stones	Dillard Maul	Hamlets Mauls
Condition	Complete	Complete	Complete	Incomplete
Count	1	2	1	1
Weight (g)	818.1	602.8	633.9	2000
Length	16.2	11.1	11.4	19.5
Width	10.8	7.6	8.5	11.5
Thickness	3	5	4.4	5.9
Surface 1 Area	154.8	27.4	0	0
Surface 2 Area	153	31.7	0	0

Table 3.12. Dimensions of Polishing Stones and Mauls at The Dillard Site and The Hamlet Sites.

Analysis of Artifact Assemblages at Each Site

Though the hamlet sites' assemblages are arguably more comparable to the Dillard site assemblage when grouped, this section will assess some of the basic variation in individual site assemblages. This will further contrast the scale of the Dillard site to individual hamlets, as well as draw distinctions between each hamlet site's separate history. However, because the assemblages at individual hamlet sites are, in some cases, as small as only one mano (at the TJ Smith site, 5MT10736), the analyses in this section will not be as detailed as the previous sections.

The Dillard site, of course, had a much larger and more varied assemblage than any of the hamlet sites (Figure 3.40), with 102 ground stone artifacts of eight different types. The Ridgeline site (5MT10711) had the next largest assemblage (31 ground stone artifacts of four types), and was also the next largest site, with one oversized pithouse, three pit rooms, one midden, and two extramural use surfaces (Table 1.2). Mueller Little House (5MT10631), one of the smaller sites based on structure and non-structure count, had 15 ground stone artifacts of four types from its only one double-chambered pithouse, one mixed midden deposit, and one extramural use-surface. The Switchback site assemblage had nine ground stone artifacts of three types from its one double-chambered pithouse, one pit room, two middens, and one mixed deposit. Portulaca Point's (5MT10709) ground stone assemblage was only three artifacts, each of a different type, from the double-chambered pithouse, pit room, and two middens excavated there. Lastly, the TJ Smith site (5MT2032) ground stone assemblage contained only one mano, though the site consisted of a single-chambered pithouse, two pit rooms, and one midden.

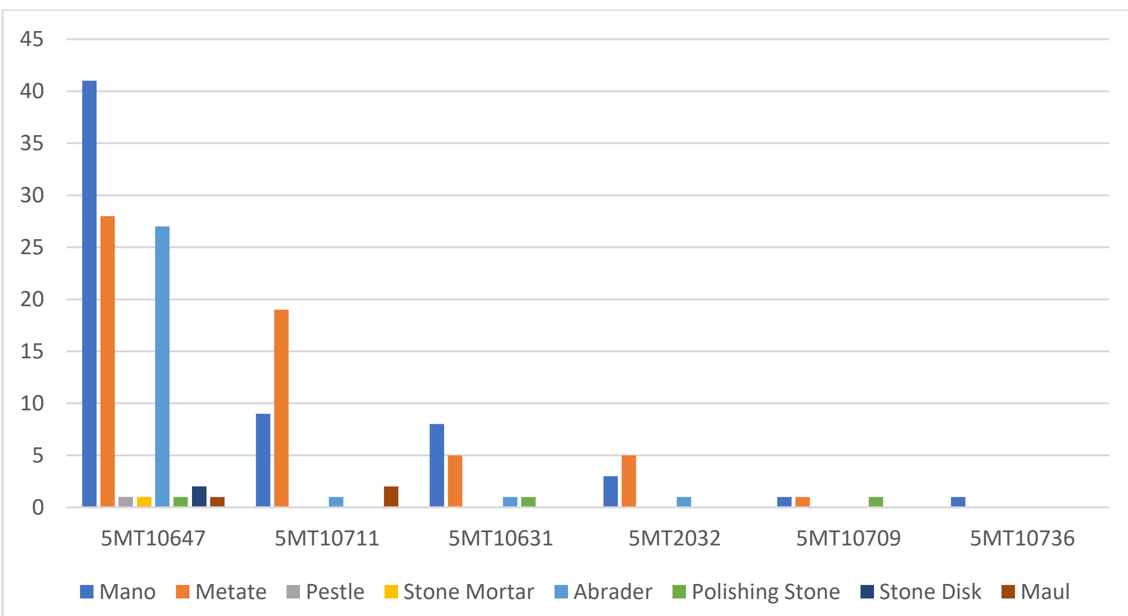


Figure 3.40. Counts of Artifact Categories at Each Sample Site.

Adams states that at most archaeological sites, manos should outnumber metates significantly, since they are used and worn out in a much shorter time and are more likely to be broken and discarded (2014). This is only true for two of the sample sites, however. Mueller Little House (5MT10631) had the highest number of manos compared to metates, followed by the Dillard Site (Table 3.13). The TJ Smith site (5MT10736) had one mano but no metates, while Portulaca Point (5MT10709) had only one mano and one metate. Both the Ridgeline site (5MT10711) and the Switchback site (5MT2032) had roughly twice as many metates as manos. In these cases, particularly at Ridgeline, manos may have been more frequently recycled into other tools, however, while in later periods ground stone is frequently recycled into building material, this is unlikely to be the case at Basketmaker III sites, where most building material consists of adobe, wood, and stone slabs, not stone blocks. Perhaps at Ridgeline, manos were more likely to end up discarded away from the site, while metates remained at the site after their use lives ended, as their larger size made them less transportable. However, the samples from Portulaca Point and the TJ Smith site were small enough that the ratios should be understood with caution.

	5MT10647	**5MT10711**	**5MT10631**	**5MT2032**	**5M10709**	**5MT10736**
Manos	41	9	8	3	1	1
Metates	28	19	5	5	1	0
Ratio	1.5	0.5	1.6	0.6	1	Not defined

Table 3.13. Ratios of Manos to Metates at Each Sample Site.

Figure 3.41. Two-Hand Mano from The TJ Smith Site with Edge Shaping. Fragmented from Burning. Pecked. (The Crow Canyon Archaeological Center, used with permission).

Though ground stone to grayware ratios were discussed in the previous section of this chapter, the independent examination of the hamlet sites provides further insights (Table 3.14). Three out of the five hamlet sites had much higher ratios of ground stone to grayware than the Dillard site. Portulaca Point, however, had twice as much grayware by weight as it did ground stone. The TJ Smith site had the closest to even amounts of each for any site (ratio of 1.1). While the ratios at Portulaca Point and the TJ Smith Site stand out from the rest, both sites have much smaller weights overall for both ground stone and grayware than any of the other sites, which may affect their ratios.

	5MT10647	5MT10711	5MT10631	5MT2032	5MT10709	5MT10736
Ground Stone (g)	137,107.6	55,969.5	26,128.4	25,794.3	1,716.8	3,157
Grayware (g)	84,076.2	17,376	7,048.5	6,007.8	3,443.1	2,999.5
Ratio	1.6	3.2	3.7	4.3	0.5	1.1

Table 3.14. Ratios of Ground Stone to Grayware at Each Sample Site.

If we accept the ratios as indicative, the Dillard site has an average amount of ground stone for its assemblage size. The Switchback site has the highest amount of ground stone relative to its grayware, having a relatively average weight of ground stone but low grayware weight. These results might loosely indicate that grinding was a more important activity at Switchback, Mueller Little House, and Ridgeline, while it was an activity of average importance at the Dillard site and the TJ Smith site, and much less important at Portulaca Point.

Analysis by Architectural Block at the Dillard Site

Architectural blocks are an interpretive spatial unit used to subdivide a site. Structures and nonstructures within an architectural block were, presumably, more closely related, and represent areas used most frequently by a specific set of people. Figure 1.9 illustrates the architectural blocks on the Dillard site, which is the only site in this study to be subdivided into blocks. Figure 3.42 represents the counts of each artifact category represented in each block. Blocks 100 and 200 were close spatially but were divided into separate architectural units based on the types of structures within each.

Block 100 included the great kiva and two middens; its ground stone assemblage had relatively low counts of manos, abraders, and a metate. Blocks 200 and 300 were the most comparable, representing residential neighborhoods of the Dillard site, with multiple pitstructures and middens. Block 200 had more structures and larger middens, however, and this is reflected in its ground stone assemblage. Block 200 contained the most ground stone tools of any block (n=55), as well as the most variety of tool types (n=6), consisting of manos, metates, the pestle, abraders, a polishing stone and a maul. Block 300 contained manos, metates, the stone mortar and abraders. Block 500 consisted of a double-chambered pithouse and midden, but its only ground stone was a single mano, suggesting that residents there did not use nearly as many ground stone tools as those living in blocks 200 and 300.

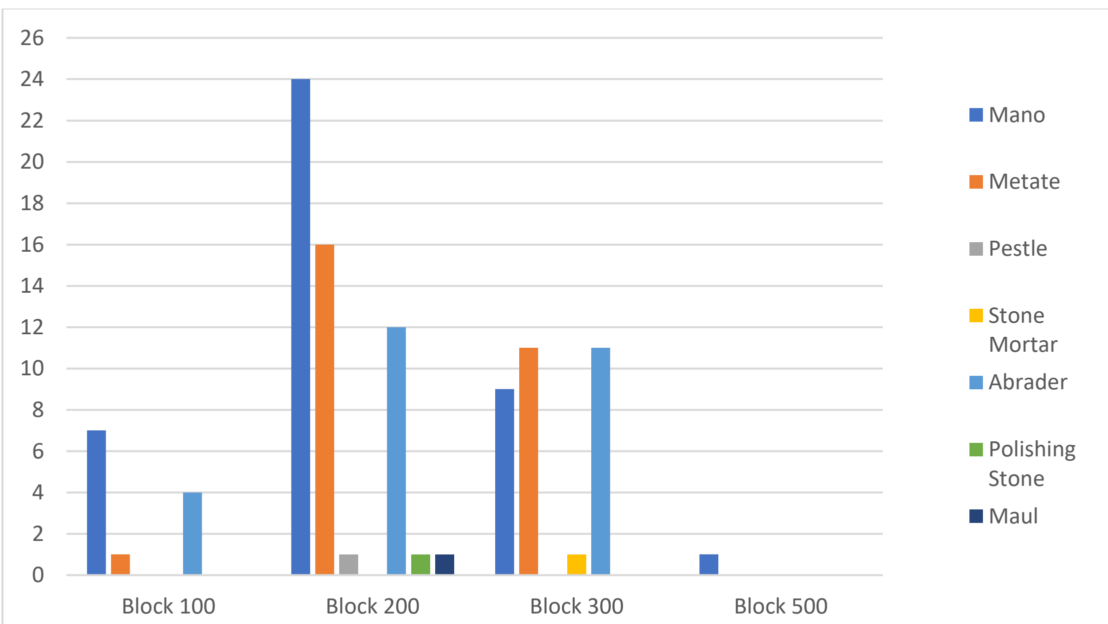


Figure 3.42. Artifact Categories by Architectural Block at The Dillard Site.

Figure 3.43 details the material types used in each Dillard site architectural block. Block 200 has the most variety, with 78% of tools made of sandstone, but the remaining

22% made of five additional materials. Block 100 materials consisted of 67% sandstone, 25% quartzite, and the remaining 8% of unknown silicified sandstone. Block 300 contained the same three material types as block 100 in the same order of frequencies, but with a higher percentage of sandstone (91%). This preference for the same material types may indicate a relationship between the two blocks; perhaps the residents of block 300 manufactured the ground stone that was used within the great kiva.

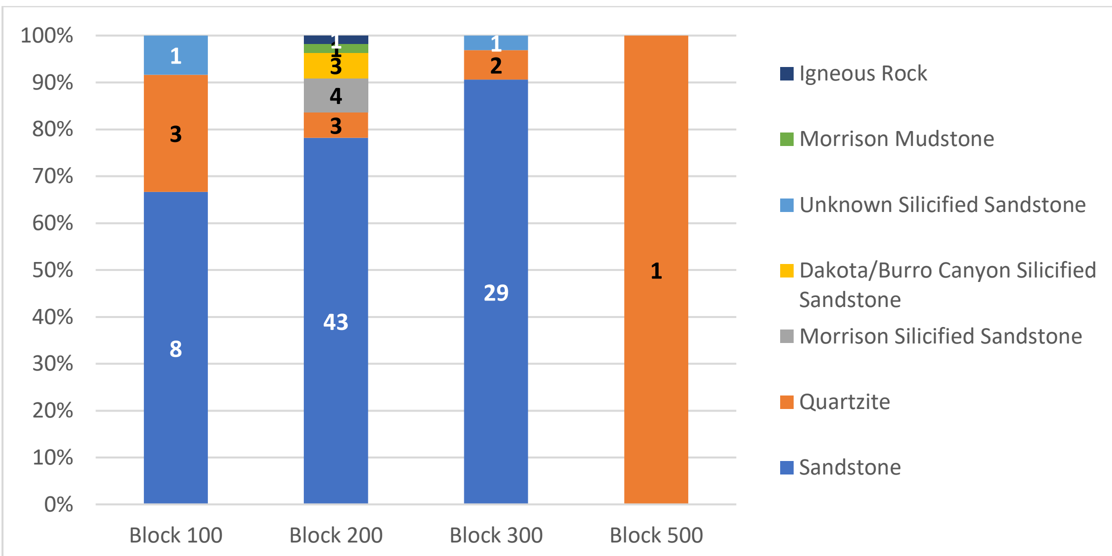


Figure 3.43. Material Type by Architectural Block at The Dillard Site.

Figure 3.44 shows the percentage of ground stone tools from each architectural block by both design and use. Half of the objects from block 100 were strategic and single-use, the most formal category. An additional 33% were expedient and single-use, meaning that a total of 83% of the tools were single-use. The remaining 17% were strategic, multiple-use tools. None of the ground stone from block 100 was expedient and multiple-use, which is the least formal tool category. Blocks 200 and 300 both contained all four combinations of design and use, in the same order of frequency. Strategic, single-use tools were specifically designed for one purpose, and were the most common, likely because they were the best fit for the tasks at hand. The secondary preference for expedient, single-use tools indicates an overall preference for single-use tools. Expedient, multiple-use tools were the third most common type, followed by strategic, multiple-use, which was an uncommon type altogether.

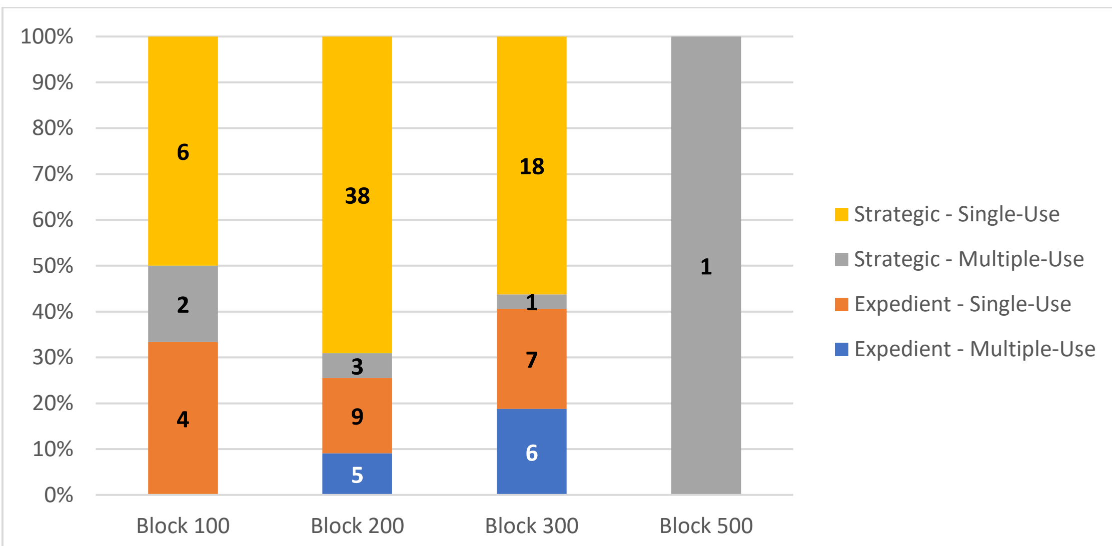


Figure 3.44. Design and Use by Architectural Block at The Dillard Site.

Ground stone from the Dillard site was heavily worn overall, though Figure 3.45 shows that artifacts from each of the architectural blocks were worn to different degrees. Over 58% of artifacts from block 100 were heavily worn, the highest percentage apart from the single mano from block 500. However, 25% were only lightly worn, also the highest percentage. Blocks 200 and 300 again had similar percentages, though block 300 had a slightly higher percent of lightly worn ground stone. Artifacts from blocks 100 and

200 both had increased coarseness on approximately 50% of their artifacts, while block 300 had the highest percent of pecked artifacts at 59% (Figure 3.46).

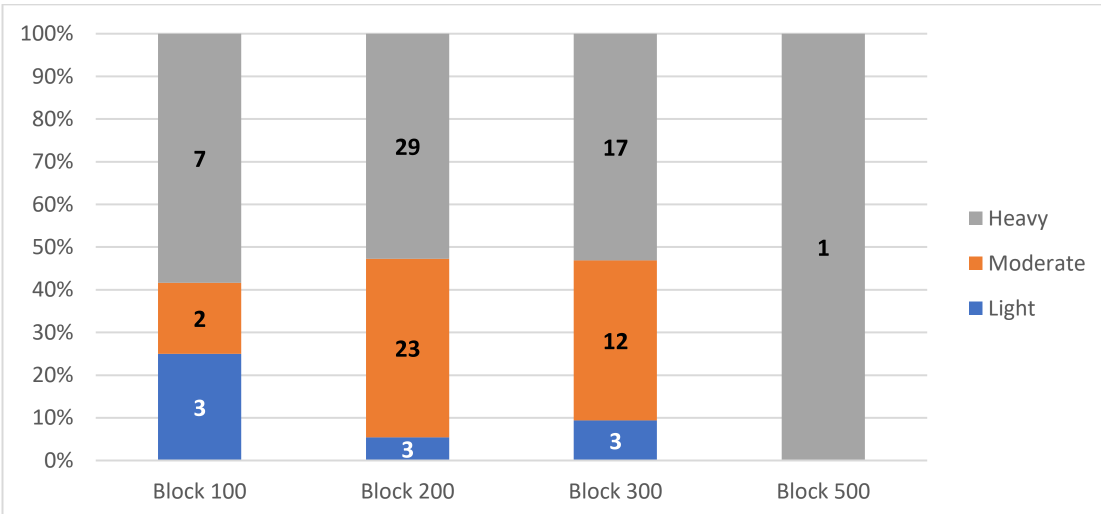


Figure 3.45. Degree of Wear by Architectural Block at The Dillard Site.

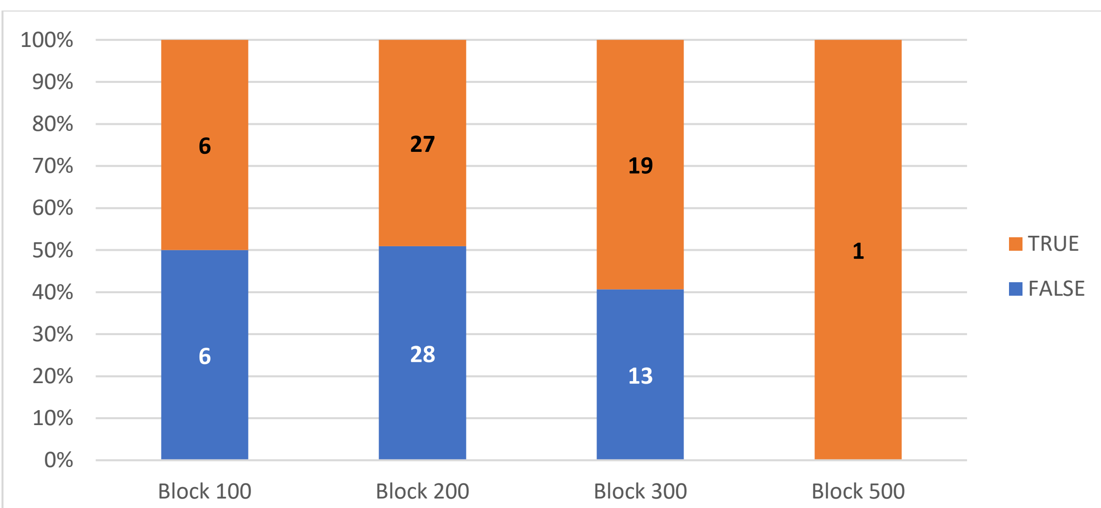


Figure 3.46. Increased Coarseness by Architectural Block at The Dillard Site.

Analysis by Structure Functional Category

As part of the Basketmaker Communities Project, each excavated structure was assigned to a functional category to provide an additional level of interpretation. Table 3.15 identifies the functional categories and the count of each structure type included in this study (See Table 1.1 for structure type definitions). The only public architecture was the Dillard site's great kiva. At the Dillard site, permanent housing included six double-chambered pithouses, one single-chambered pithouse and one large, single-chambered pithouse. The hamlets each only had one permanent housing structure, and these consisted of one oversized pithouse, three double-chambered pithouses, and one single-chambered pithouse. Only the Dillard site had temporary housing, which consisted of one large, shallow double-chambered pithouse and two large, shallow, single-chambered pithouses. Specialized activity pit rooms had a wide variety of inferred functions. The most common function was storage, though both pit room 117 at Ridgeline (5MT10711) and pit room 113 at Switchback (5MT2032) were interpreted as a pottery production rooms. Pit room 228 at the Dillard site (5MT10647) was a mealing room associated with structure 205-226 and was located immediately southwest of the great kiva. The room had a hearth, perhaps suggesting extensive use, or even use as a living space.

Functional Category	Structure Types	Dillard	Hamlets
Public Architecture	Great Kiva	1	0
Permanent Housing	Oversized Pithouse	0	1
	Double-Chambered Pithouse	6	3
	Large, Single-Chambered Pithouse	1	0
	Single-Chambered Pithouse	1	1
	Total	8	5

Temporary Housing	Large, Shallow Double-Chambered Pithouse	1	0
	Large, Shallow Single-Chambered Pithouse	2	0
	Total	3	0
Specialized Activity	Pit Room	6	7

Table 3.15. Functional Categories and Structure Types at The Sample Sites.

Figure 3.47 depicts the counts of each ground stone artifact type for each functional category, with the Dillard site and hamlets separated. The Dillard great kiva had low numbers of manos, abraders, and a metate. Permanent housing constituted the majority of structures for both Dillard and the hamlets, and the overall artifact counts were similar for both (Dillard n=39, hamlets n=38). However, the Dillard permanent housing had seven types of artifacts compared to the hamlets' four. Manos and metates were the majority of both assemblages, but Dillard permanent housing also included eleven abraders, the stone mortar and pestle, a maul and a polishing stone. Temporary housing contained low numbers of manos, metates, and abraders, the most common types in the total assemblage.

Most of the excavated specialized activity pit rooms did not contain ground stone, and those that did had few ground stone artifacts. At the Dillard site (5MT10647), structure 228, the mealing and storage room, contained one mano and five metates. At the Ridgeline site (5MT10711), one mano was found in a slab-lined pit room (structure 117) interpreted to be used for pottery production based on the four fragmented vessels and raw clay found inside. Though no pigment or clay was detected on its surface, the ends of the igneous cobble mano were battered, indicating that it may have been used to break up clay. Structure 113 at the Switchback site (5MT2032) also contained raw clay, and the trough metate found within could have been used in the clay production process, either processing temper, raw clay, or both. Lastly, pit room 115 at Portulaca Point (5MT10709) was a slab-lined storage room containing one polishing stone.

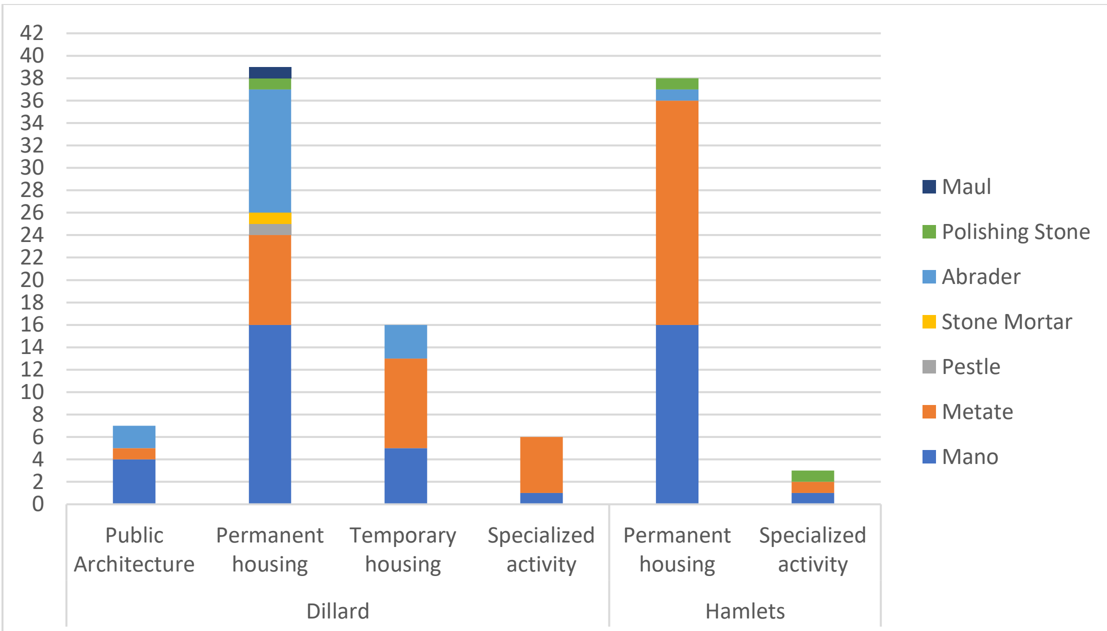


Figure 3.47. Counts of Artifact Categories from Structure Functional Categories.

An initial glance at Figure 3.47 might suggest that manos and metates were most widely used in permanent housing, followed by temporary housing, and public architecture and specialized function. However, as Figure 3.48 shows, there were very different artifact counts within structures of the same functional type. Pithouse 205-226 had over twice as many artifacts as pithouse 220-234, the next largest ground stone assemblage, which also had the most variety of artifact types and the metate on its stone rests left on the structure floor. Interestingly, though structure 505-508 had a bin feature that was interpreted as a possible metate bin, it contained only a single mano in its ground stone assemblage. Artifact counts from temporary housing were skewed by pithouse 312-324, which had 13 ground stone tools, compared to just one and two at the other two pithouses, respectively.

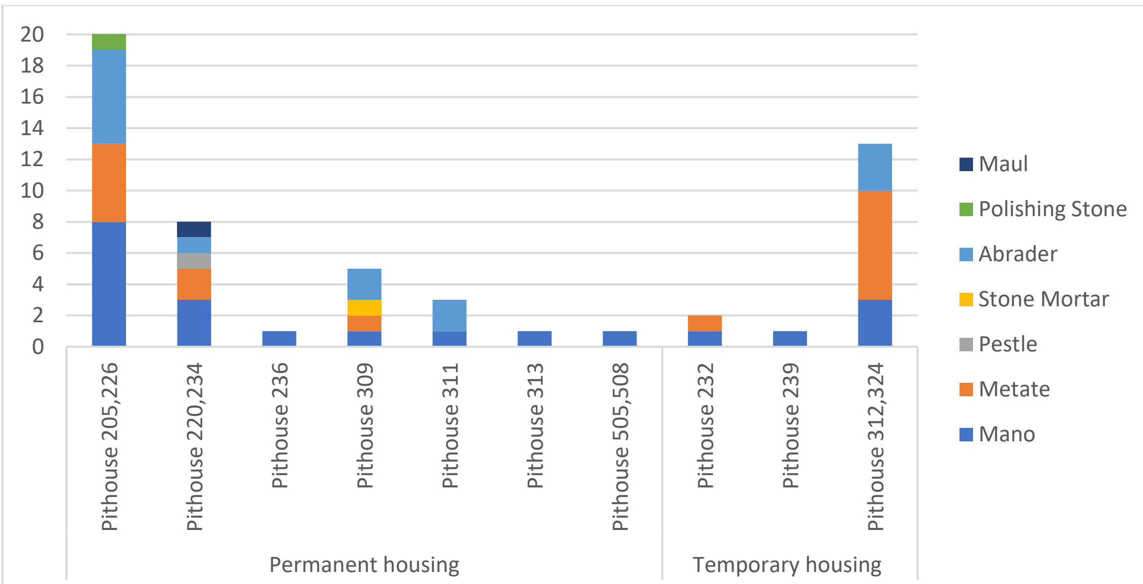


Figure 3.48. Counts of Artifact Categories in Each Permanent and Temporary Housing Structure at The Dillard Site.

The ground stone counts for permanent housing structures at the hamlet sites were also disparate, as shown in Figure 3.49. Pithouse 101-103 at Ridgeline (5MT10711) contained the highest number of ground stone tools (n=16), though all were manos and metates, while pithouse 101-102-114 at Mueller Little House (5MT10631) had thirteen tools of twice as many types as the other sites (n=4). The remaining permanent housing pitstructures only contained manos and metates, with assemblages of six, two and one, respectively.

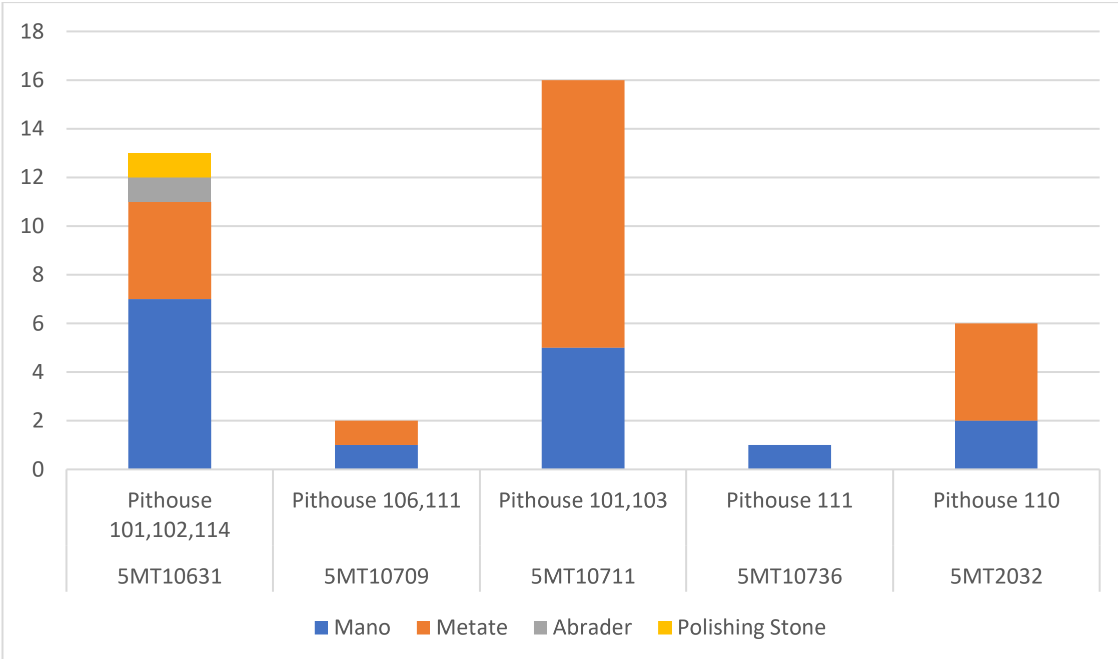


Figure 3.49. Counts of Artifact Categories in Each Permanent Housing Structure at The Hamlet Sites.

Figure 3.50 depicts design and use of ground stone from the structure functional categories. Artifacts from the great kiva were almost exclusively single-use, and mostly strategically made. At the Dillard site, permanent housing had each of the four combinations present, though single-use, strategic artifacts comprised over 50% of the artifacts. At the hamlet sites, 66% were single-use and strategic, with only 5% being multiple-use and expedient, the least formal category. Temporary housing also had all four design and use combinations, but 69% of the artifacts were single-use and strategic. Ground stone from specialized activity rooms at the Dillard site was exclusively single-use and strategic, suggesting that tools used in those contexts were generally more formal. This is not the case at the hamlets, where two of the three tools were multiple-use and expedient, the least formal category.

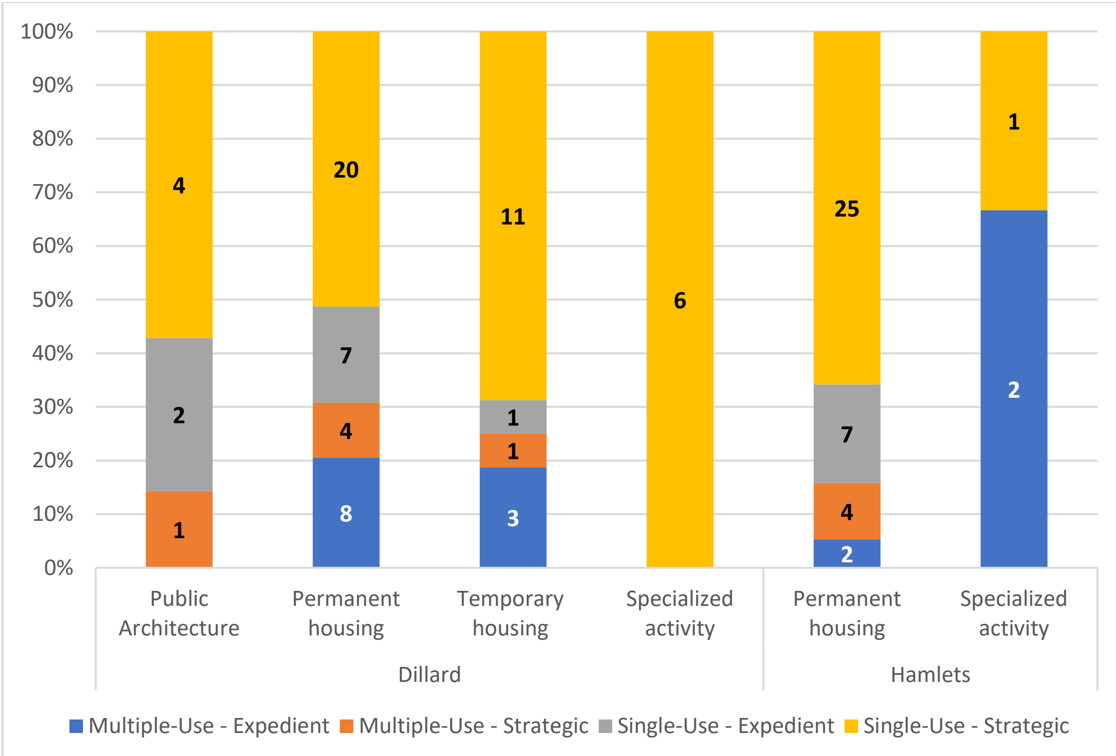


Figure 3.50. Design and Use of Artifacts from Structural Functional Types at The Dillard site and The Hamlet Sites.

Figure 3.51 illustrates the degree of wear on ground stone from each of the structure functional types. Ground stone from the great kiva was almost evenly split between light, moderate and heavy wear. At the Dillard site, ground stone from permanent housing was 49% heavily worn, 41% moderately worn, and only 10% lightly worn. Permanent housing at the hamlets also contained mostly heavily and moderately worn ground stone but had a higher percentage of lightly worn tools (24%). Ground stone from temporary housing was overwhelmingly heavily worn at 63%, with 31% moderately worn and only 6% having light wear. This may indicate that ground stone belonging to temporary households was utilized extensively, year after year. Ground stone from specialized activity rooms at the hamlet sites was evenly split between degrees of wear. At the Dillard site, however, they only heavily or moderately worn ground stone. This likely indicates that specialized activity rooms were regularly used for grinding.

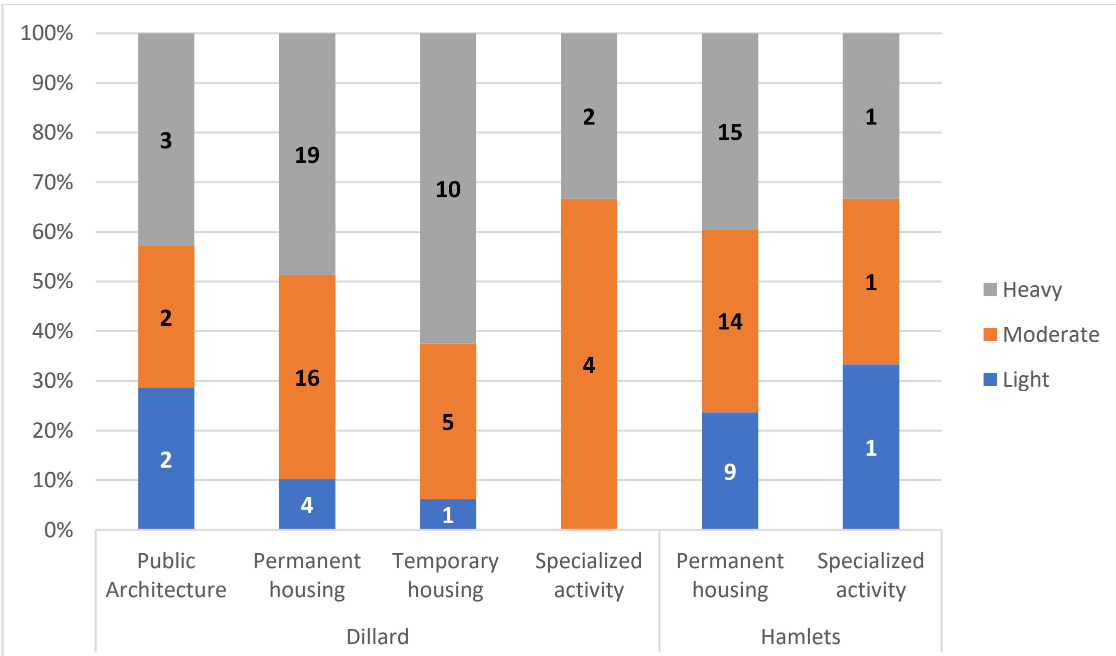


Figure 3.51. Degree of Wear at Structure Functional Types at The Dillard Site and The Hamlet Sites.

Figure 3.52 depicts the counts of ground stone with and without increased coarseness from each of the structure functional types. Artifacts from the Dillard great kiva were more often pecked. Ground stone from permanent housing at the Dillard site was almost equally likely to be pecked or not pecked, while at the hamlet sites' permanent housing, tools were pecked almost twice as often as not. At the Dillard temporary housing, artifacts were more often pecked, though the difference was not as pronounced as at other structure types. While at the hamlets' specialized activity rooms, two of the three tools did not have increased coarseness, at the Dillard site, all six were pecked. This is the highest percentage of pecking for the structure types, which suggests a higher investment in these particular tools. Ground stone from the Dillard specialized activity rooms was strategically made, and even though the heavy use of tools in this category would have worn them quickly, they were pecked so they could be kept in use.

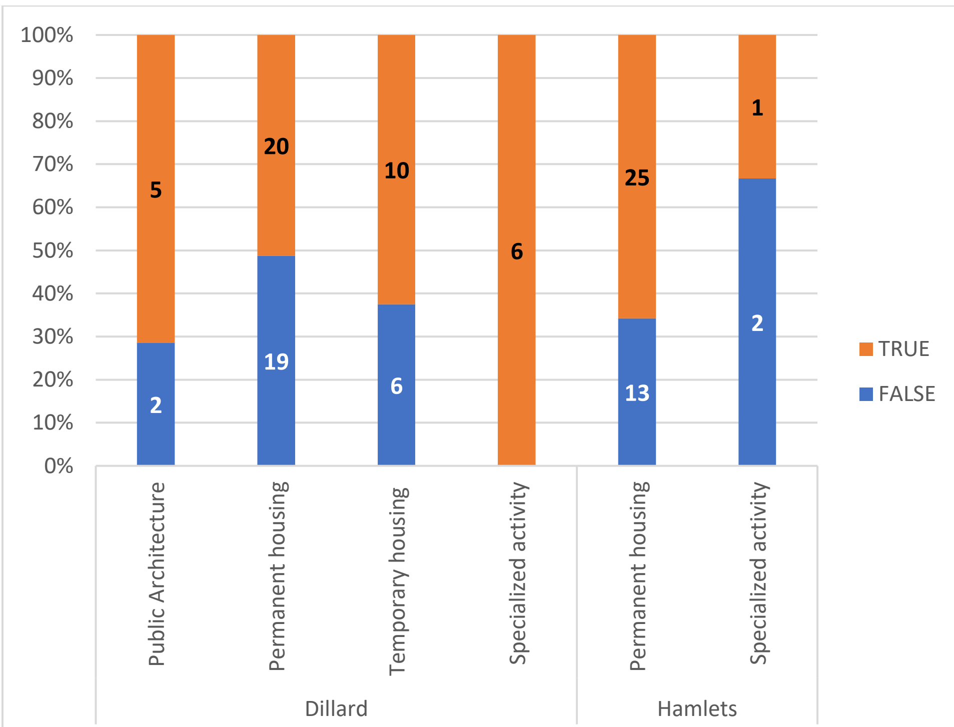


Figure 3.52. Increased Coarseness by Structure Functional Type at The Dillard Site and The Hamlet Sites.

CHAPTER FOUR

CONCLUSION

Through the ground stone analysis conducted in this thesis, differences in the food production dynamics of the Dillard site and the hamlet sites have come to light. The Dillard site contained more types of ground stone tools, indicating that residents used a wider variety of grinding techniques. The presence of a pestle and stone mortar represent the diverse strategies used to process foods and other substances and indicate a difference beyond a simple distinction in strokes used with manos and metates. The Dillard site additionally contained 90% of the abraders in the assemblage, which suggests that the objects produced with abraders were differentially manufactured. The beads, bone, and mineral tools or crafts produced by abrading were perhaps less vital to sustaining a population than manos and metates as food production tools, and it may be the case that only at an aggregated site would certain individuals have had time for specialized object production on a larger scale. The hamlet sites had fewer tools and fewer types of tools, and their assemblages consisted of higher counts of more common tools, such as manos and metates for food production, and mauls for construction.

The Dillard site had only slightly more two-hand manos than one-hand manos, and contained even higher counts of untyped manos, likely due to the site’s long occupation, leading to an accumulation of broken tools. The hamlet sites, however, had twice as many two-hand manos as one-hand, and both types were more efficient than their counterparts at the Dillard site. This signals that residents of the hamlet sites were more concerned about the amount of ground product resulting from a grinding session.

With fewer residents at the hamlet sites, food production for the household level would require shorter and more productive grinding sessions in order to balance the additional household maintenance responsibilities. Slab metates, by far the most frequent type in the assemblage, were larger in all dimensions apart from thickness at the Dillard site, and were more formally made. There were significantly more metates at the hamlet sites overall, though these were more often expedient tools. This suggests that fewer women used metates at the Dillard site, but those metates were larger and more formal, which would be beneficial for longer grinding sessions, while at the hamlet sites, more women ground more frequently but in shorter sessions.

Lithic material types were more varied at the Dillard site, while there were a more restricted number of types at the hamlet sites. Two-hand manos are especially notable: at the Dillard site, they are made of five material types, while they are exclusively made of sandstone at the hamlets. Additionally, manos from the Dillard site were more variable in their granularities, while at the hamlets, the local sandstone was almost exclusively fine-grained. Historically, Hopi, Zuni and other Pueblos used sets of grinding tools, beginning with the coarsest tools first, then medium, then fine-grained tools to finish the process (Bartlett 1933), which may have been the case at the Dillard site. This process was not intended to be more efficient but to create the opportunity for women to work in groups, making the task more enjoyable and social. Though there was no evidence of multiple permanent mealing bins as at later Pueblos, grinding may have been more of a social activity at the Dillard site in addition to its subsistence role.

Residents of the Dillard site distinctly preferred strategically designed tools compared to those at the hamlet sites, either comparable or higher percentages of strategic tools for all artifact categories. Strategic tools at the Dillard site were also much more worn than expedient tools, while at the hamlets, the degree of wear was less distinct between tool designs. Metates were much more often strategically designed at the Dillard site, while half of the slab metates at the hamlets were expediently designed. Single-use tools were preferred comparably at the Dillard site and the hamlets. Formal, well-made tools at the Dillard site could have been a source of pride for the makers, and were likely more effective at their job, making longer grinding sessions less tiring or at least more productive. Perhaps at the hamlets, it was not worth the time to design and manufacture formal tools for every job, particularly if grinding was a shorter, daily task. If only certain women were grinding food for the community at the Dillard site, the comfortably and effectively shaped tools would be more useful for longer grinding sessions.

Almost every artifact category exhibited significantly heavier wear at the Dillard site than the hamlets. In particular, manos were much more heavily worn; this may be due to the higher investment in strategically designed manos being kept in use longer rather than replaced. Slab metates had heavier wear at the hamlet sites, though all other metates were more heavily worn at the Dillard site. Slab and trough metates were more often pecked at the hamlet sites, following their heavier use wear. One factor in the differential use wear of manos and metates at Dillard and the hamlets is the number of ground surfaces utilized on each: manos at the hamlets were more likely to have multiple ground surfaces, meaning they may have been as extensively worn as the Dillard manos, but on multiple surfaces instead of a single, more heavily worn surface. Metates were more often utilized on multiple surfaces at the Dillard site, while at the hamlets, the wear was more often concentrated on one grinding surface.

Manos and metates were used and maintained in different ways at the Dillard site and the hamlets. While both one-hand and two-hand manos at the Dillard site had comparable instances of linear and multi-directional striations, the stroke patterns were differentiated by mano type at the hamlets, with one-hand manos more frequently used with a circular stroke, and two-hand manos exclusively used with a reciprocal stroke. Metates were also used with varying stroke patterns at the Dillard site, while slab metates, the most common type, were most often utilized with a reciprocal stroke at the hamlets.

Mano profiles were distinct between the Dillard site and the hamlet sites, with both one-hand and two-hand manos at the Dillard site exhibiting various profiles, while both mano types from the hamlets had fewer profile shapes, particularly two-hand manos. Both grinding stroke pattern and wear management strategies were habits likely passed down from one generation of women to the next. Stroke pattern may be related to which materials were being processed and for which purpose, while mano profiles may reflect the natural qualities of the lithic material used as a mano, but both represent different grinding traditions. This could indicate that the residents of the hamlets learned relatively consistent methods of grinding, while residents of the Dillard site may have learned different strategies that the Basketmaker migrants brought with them.

Within the Dillard site, differences in the ground stone assemblages of each of the architectural blocks revealed that grinding tasks may have been delegated to particular blocks. Architectural blocks 200 and 300, the larger, domestic blocks contained the vast majority of the ground stone. Block 300 additionally showed striking similarities of material choice to block 100, which contained the great kiva, perhaps indicating that the ground stone found in the great kiva was produced by residents of block 300. Architectural blocks 400 and 500 were also residential blocks with one pithouse each and contained only one mano between them, strongly suggesting grinding did not take place within their structures. If residents of these blocks did not grind their own food, residents of blocks 200 or 300 may have ground enough to feed the community rather than only their own households.

Permanent housing at the Dillard site contained the most types of artifacts of any structure functional category, which suggests that permanent houses were the main location for grinding activities. However, pithouse 205-226 had over twice as many ground stone artifacts as any other pithouse, resulting in a high count for permanent housing overall. In fact, four of the seven permanent housing structure contained only three tools or less. This strongly suggests that certain pithouses had a larger share of grinding responsibility than other houses and may indicate sharing of ground products between households.

Ground stone from temporary housing at the Dillard site mostly came from pithouse 312-324, which had higher counts than all of the permanent houses apart from 205-226. This may indicate that visitors to the site during ceremonial gatherings, who would have been housed in these structures, ground either their own food or contributed to the surplus, or that tools may have been stored or used within the temporary housing when not occupied, providing women an additional space to carry out their tasks. Both public architecture and temporary housing contained only manos, metates and abraders, and the similarity of their ground stone artifact types might bolster the argument that temporary housing is in fact related to public architecture and the events that took place within.

Both permanent and temporary housing have all four combinations of strategic and expedient design with single and multiple tool uses, representing the variety of tool types used in those structure types. Ground stone from both permanent and temporary housing had mostly moderate or heavy wear, though artifacts from permanent housing were equally likely to have increased coarseness or not, while artifacts from temporary housing were almost twice as likely to be pecked. Ground stone from the great kiva was slightly more formal: the assemblage contained no expedient/multiple-use tools, the least formal category, and was dominated by strategic/single-use tools, the most formal. These artifacts additionally had an almost even split between light, moderate and heavy wear, implying that they were not used as often as the tools from housing structures. However, they were more than twice as likely to be pecked, and when considered with their more formal design and use, could suggest a less intensive, more specialized use.

Ground stone from the specialized activity pit room at Dillard stood out for several reasons. All six manos and metates were strategically made, single-use tools. They were more heavily worn than those from other structure types, and all six were pecked. The occurrence of formalized use and design, with the heavier than average wear indicates intensive use in longer grinding sessions. Additionally, the room was located immediately southwest of the great kiva and contained a hearth. This suggests that the room was more specialized than a simple storage room. The proximity to the public, ritual space of the great kiva may reflect a similarly important ritual function for the room. The presence of a hearth may also indicate that a greater amount of time was spent in the room, and that a wider variety of activities took place within.

The specialized activity room (structure 228) may have been a space where grinding took place above the household level, perhaps generating a surplus in intensive grinding sessions, to be distributed among households or to provide for visitors during gatherings at the great kiva. Structure 228 was interpreted as a food processing and preparation room in the annual report summarizing its excavation, and this interpretation is only bolstered through the ground stone analysis. This room was clearly used for grinding, and the grinding that took place there was more intense and focused than that at the habitations.

At the hamlets, grinding likely took place within households, and there was less evidence for grinding within specialized activity pit rooms. This strongly suggests that grinding was a household task, with each household responsible for its own grinding needs. Ground stone from permanent housing at the hamlets was predominantly strategically designed and single-use tools. Additionally, twice as many tools were pecked as were not. The specialized activity rooms only contained one ground stone tool each, suggesting they were not regularly used for grinding activities, further indicating that grinding did not take place above the household level.

In summary, residents of the Dillard site ground in more intensive sessions, indicated by the preference for well-shaped, formal tools that would make longer grinding sessions more comfortable. Their tools were much more heavily worn, the result of grinding more total product over time, for use by a larger population over a longer site occupation. Ground stone tools were more often pecked to increase their coarseness, showing an investment in prolonging tool use life. When using grayware as a representation of the overall site assemblage, there were relatively fewer ground stone tools at the Dillard site. Though there were more tools overall at Dillard, a relatively smaller portion of the population likely ground in intense session using tools that were more comfortable. A larger population could grind a surplus, producing food beyond the household level, rather than only grinding enough food to feed their families.

Grinding may have been conducted within households to a relatively lesser degree at the Dillard site than at the hamlets because grinding was a task assigned to specific women for communal benefit, supplementing households' own ground products. Ground stone artifacts were concentrated in only certain permanent houses, while most permanent housing had only low numbers, indicating that grinding tasks were the responsibility of certain households. The presence of at least one specialized activity room that was a locus of intensive grinding would have alleviated the need for each household to grind all of their own foods. Structure 228, and potentially the other specialized activity rooms, may have served as women's spaces, in which they produced important commodities and oversaw their distribution in their community. This intensive grinding supplementing household grinding would have left more time for other activities, such as craft production with abraders, or ceremonies within the great kiva.

The hamlet sites all had smaller populations than the Dillard site, and in order to balance the multitude of household and community tasks, grinding would not be able to be condensed into intensive sessions, but would be extensive, in shorter sessions. The hamlet sites also had a lesser need for a surplus as smaller communities, and their population did not expand and decrease as the Dillard site population did. For the hamlet sites overall, as well as for most of the sites individually, there was a higher amount of ground stone relative to the grayware assemblage. In addition, the higher count of metates at the hamlets than at the Dillard site indicates the prevalence and prioritization of grinding tasks.

Ground stone tool users at the hamlets expended less effort to shape their tools before use, perhaps indicating less concern with the comfort of using the tools because grinding sessions were shorter and more incorporated into daily tasks, rather than being separated in a specialized space. The higher efficiency of both mano types at the hamlets when compared to manos from the Dillard site would have been important to increase the productivity of less intensive grinding sessions. Grinding took place within houses, likely producing enough to feed those households through regular but shorter grinding sessions.

The findings in this ground stone analysis have implications for broader archaeological questions about the Basketmaker III period and the differences in community dynamics between an aggregated site and smaller habitation sites. Though the results of this analysis have at times disrupted notions of ground stone change over time, they have also aligned with those notions. Specifically, metate types are overwhelmingly dominated by slab metates at the earlier Dillard site and the later hamlets, showing that changing preferences for ground stone were not drastic. However, basin metates appear to be secondarily preferred at the Dillard site, and trough metates the second choice at the hamlets. Along with the increasing efficiency of manos through time, this suggests that intensified processing and reliance on maize influence the ground stone choices.

This study has also shed light on the social differences between Dillard, as an aggregated community, and the hamlets. While the hamlet communities almost certainly interacted with each other and the Dillard site, they did not have the public architecture or the same evidence for social cooperation through communal grinding and shared ground food products. While it is likely that the hamlets participated in the same social network as the Dillard site, residents of the Dillard site had closer spatial proximity to the great kiva and the specialized mealing room 228, likely indicating a different role within the larger Basketmaker III cultural landscape. The Dillard site was not simple an agglomeration of hamlet neighborhoods but a site with a more complex level of social integration and whose residents were differentiated from residents of the hamlets.

Though the larger ground stone artifact count at the Dillard site likely influenced the results, the greater variation in material choice and mano cross-section profiles at the Dillard site may be due in part to the differing cultural backgrounds of the occupants. Sharing grinding responsibilities and ground products could promote community cohesion at the Dillard site and promote cooperation between previously disparate cultural groups, who had distinct populations up until Basketmaker III migration to the study area. These migrants may have formed a new group identity through the shared production and ownership of ground products, as both physical and spiritual nourishment.

Appendix A contains the Crow Canyon Archaeological Center ground stone analysis form and explanation of procedures, so that others may integrate these analysis practices into their work. The methods are designed to be applicable to an in-field or laboratory analysis, conducted by professionals or lay-persons with minimal training and supervision. While this analysis form outlines quick and thorough data collection methods, even briefer studies may be required, and can be useful. For my study specifically, the most informative attributes were artifact dimensions, degree of wear, use, design, and mano efficiency. Though each variable provides important insights, it is strongly preferable to conduct a smaller-scale ground stone analysis, choosing analytic variables wisely, than to skip ground stone analysis due to time or other constraints. This study has aimed be an example of the depth of interpretation that can be gleaned from a relatively simple ground stone analysis, and to encourage others to give this artifact class the analytic attention it so well deserves.

REFERENCES

Adams, Jenny L.
2014 *Ground Stone Analysis: A Technological Approach*. The University of Utah Press, Salt Lake City.

Adams, Karen R. and Kenneth Lee Petersen
1999 Environment. In *Colorado Prehistory: A Context for the Southwestern Colorado River Basin*, edited by William D. Lipe, Mark D. Varien, and Richard H. Wilshusen, pp. 14-50, Colorado Council of Professional Archaeologists.

Bartlett, Katharine
1933 *Pueblo Milling Stones of The Flagstaff Region and Their Relation to Others in The Southwest: A Study in Progressive Efficiency*. Museum of Northern Arizona, Bulletin No. 3, Flagstaff.

The Crow Canyon Archaeological Center
2001 *The Crow Canyon Archaeological Center Field Manual*. Document on file, Crow Canyon Archaeological Center.

2014 Basketmaker II: 500 B.C. to A.D. 500. In *Peoples of the Mesa Verde Region*. Electronic document, https://www.crowcanyon.org/educationproducts/peoples_mesa_verde/basketmaker_II_overview.asp. Accessed: 5 November, 2019.

Crown, Patricia L.
2000 Gendered Tasks, Power, and Prestige in the Prehispanic American Southwest. In *Women and Men in the Prehispanic Southwest*, edited by Patricia L. Crown, pp. 3-41, School of American Research Press, Santa Fe, New Mexico.

Diederichs, Shanna R.
2016 *Basketmaker III Colonization and the San Juan Frontier*. Master’s thesis, Department of Anthropology, Northern Arizona University, Flagstaff.

Diederichs, Shanna R. and Steven R. Copeland
2012 *The Basketmaker Communities Project Annual Report, 2011 Field Season.* Electronic document, http://www.crowcanyon.org/basketmaker2011. Accessed: 1 August 2019.

2013 *The Basketmaker Communities Project Annual Report, 2012 Field Season.* Electronic document, http://www.crowcanyon.org/basketmaker2012. Accessed: 1 August 2019.

Diederichs, Shanna R., Steven R. Copeland, and Caitlin A. Sommer
2014 *The Basketmaker Communities Project Annual Report, 2013 Field Season.* Electronic document, http://www.crowcanyon.org/basketmaker2013. Accessed: 1 August 2019.

Geib, Phil R.
2014 Stone Artifacts of the Falls Creek Rockshelters. In *Falls Creek Rockshelters Archaeological Assessment Project – Phase II*, compiled by Carl E. Connor, pp. 2.1-2.140, Dominguez Archaeological Research Group.

Geib, Phil R. and Carrie C. Heitman
2015 The Relevance of Maize Pollen for Assessing the Extent of Maize Production in Chaco Canyon. In *Chaco Revisited New Research on the Prehistory of Chaco Canyon, New Mexico* edited by Carrie C. Heitman and Stephen Plog, pp. 66-95. The University of Arizona Press, Tucson.

Heitman, Carrie C.
2016 "A Mother for All The People": Feminist Science and Chacoan Archaeology. *American Antiquity* 81(3):471-489.

Kohler, Timothy A., Matt Pier Glaude, Jeane-Pierre Bocquet-Appel, and Brian M. Kemp
2008 The Neolithic Demographic Transition in the U.S. Southwest. *American Antiquity* 73(4):645-669.

Lipe, William D.
1974 A Conservation Model for American Archaeology. *Kiva* 39(3/4): 213-245.

1999 Concluding Comments. In *Colorado Prehistory: A Context for the Southwestern Colorado River Basin*, edited by William D. Lipe, Mark D. Varien, and Richard H. Wilshusen, pp. 405-435, Colorado Council of Professional Archaeologists.

Ortman, Scott G., Erin L. Baxter, Carole L. Graham, G. Robin Lyle, Lew W. Matis, Jamie A. Merewether, R. David Satterwhite, and Jonathan D. Till
2005 *The Crow Canyon Archaeological Center Laboratory Manual, Version 1*. Available: https://www.crowcanyon.org/ResearchReports/LabManual/LaboratoryManual.pdf. Accessed: 17 July 2018.

Ortman, Scott G., Shanna Diederichs, and Kristin A. Kuckelman
2011 *A Proposal to Conduct Archaeological Testing at Indian Camp Ranch, Montezuma Colorado*. Submitted to Colorado Office of Archaeology and Historic Preservation.

Schachner, Gregson, Kellam Throgmorton, Richard H. Wilshusen, and James R. Allison
2012 Early Pueblos in the American Southwest: The Loss of Innocence and the Origins of the Early Southwestern Village. In *Crucible of Pueblos: The Early Pueblo Period in the Northern Southwest*, edited by Richard H. Wilshusen, Gregson Schachner, and James R. Allison, pp. 1-13, Cotsen Institute of Archaeology, University of California, Los Angeles.

Sommer, Caitlin A., Shanna R. Diederichs, Susan C. Ryan, Steven R. Copeland, and Kari L. Schleher
2015 *The Basketmaker Communities Project Annual Report, 2014 Field Season.* Electronic document, http://www.crowcanyon.org/basketmaker2014. Accessed: 1 August 2019.

Sommer, Caitlin A., Susan C. Ryan, Kari L. Schleher, Grant D. Coffey, Shanna Diederichs, Steven R. Copeland, and Rebecca L. Simon.
2016 *The Basketmaker Communities Project Annual Report, 2015 Field Season.* Electronic document, http://www.crowcanyon.org/basketmaker2015. Accessed: 1 August 2019.

Sommer, Caitlin A., Susan C. Ryan, Kari L. Schleher, Shanna R. Diederichs, Steven R. Copeland, Rebecca L. Simon, and Grant D. Coffey
2017a *The Basketmaker Communities Project Annual Report, 2016 Field Season.* Electronic document, http://www.crowcanyon.org/basketmaker2014. Accessed: 1 August 2019.

2017b *The Basketmaker Communities Project Annual Report, 2017 Field Season.* Electronic document, http://www.crowcanyon.org/basketmaker2014. Accessed: 1 August 2019.

Till, Jonathan D. and Scott G. Ortman
2007 Artifacts. In *The Archaeology of Sand Canyon Pueblo: Intensive Excavations at a Late-Thirteenth-Century Village in Southwest Colorado*, edited by Kristin A. Kuckelman, The Crow Canyon Archaeological Center. Electronic document, https://www.crowcanyon.org/ResearchReports/SandCanyon/Text/scpw_artifacts.asp. Accessed: 9 October, 2019.

Varien, Mark D.
1999 *Sedentism and Mobility in a Social Landscape: Mesa Verde and Beyond*. The University of Arizona Press, Tucson.

Varien, Mark D., Scott G. Ortman, Timothy A. Kohler, Donna M. Glowacki, and David C. Johnson
2007 Historical Ecology in the Mesa Verde Region: Results from the Village Ecodyamics Project. *American Antiquity* 72(2):273-299.

Wilshusen, Richard H.
1999 Basketmaker III. In *Colorado Prehistory: A Context for the Southwestern Colorado River Basin*, edited by William D. Lipe, Mark D. Varien, and Richard H. Wilshusen, pp. 166-195, Colorado Council of Professional Archaeologists.

Wilshusen, Richard H., Scott G. Ortman, Shanna Diederichs, Donna M. Glowacki, and Grant Coffey
2012 Heartland of the Early Pueblos: The Central Mesa Verde. In *Crucible of Pueblos: The Early Pueblo Period in the Northern Southwest*, edited by Richard H. Wilshusen, Gregson Schachner, and James R. Allison, pp. 14-34, Cotsen Institute of Archaeology, University of California, Los Angeles.

Wilshusen, Richard H. and Elizabeth M. Perry
2012 Women's Central Role in Early Pueblo Change: Ground Stone, Archaeobotanical, Ceramic, Architectural, and Skeletal Evidence. In *Crucible of Pueblos: The Early Pueblo Period in the Northern Southwest*, edited by Richard H. Wilshusen, Gregson Schachner, and James R. Allison, pp. 185-197, Cotsen Institute of Archaeology, University of California, Los Angeles.

Woods Canyon Archaeological Consultants
Ca. 1991 *Summary of Archaeological Sites on the Jane Dillard Tract of Indian Camp Ranch.* Report on file, The Crow Canyon Archaeological Center.

APPENDIX A

Crow Canyon Archaeological Center Ground Stone Analysis Form

Analyst:_________________ Supervisor:_________________ Date of Analysis:______________

Provenience:

Site:________________________________ PD:_____________ FS: ______________ PL:_____________ SU:______________

Hor.:________________________________ Vert.:_____________ Feature:_______________ Bag Date:______________ Field Supervisor:____________

Condition: complete incomplete fragment

Artifact Type:

mano (one-hand / two-hand) abrader mortar (pebble / rock / shaped rock) pestle stone disk

metate (slab / trough metate / open trough / ¾-trough / basin / open basin / ¾-basin metate) pecking stone axe maul

axe/maul tchamahia other:_____________________________

Material Type:____________________ **Granularity:** fine medium coarse conglomerate mixed

If fine grained, was surface re-altered to increase coarseness? Yes No NA

Vesicular material – Vesicle Size: small large NA

Design: expedient strategic

Use: single-use multiple-use

Degree of Wear: light moderate heavy

Pigment Present? (circle one): Yes No Color:____________________________ (use Munsell)

Striations on ground surface(s): Yes No

multi-directional linear none visible

Grooves (for abraders): Yes No Number________ Internal striations visible?:

Orientation of internal striations: parallel to groove perpendicular to groove

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Measurements: Weight (indicate g or kg):_______________

Artifact dimensions: max. length______________ max. width______________ max. thickness_______________ max. diameter_______________

Trough dimensions: max. length_______________ max. width______________ max. depth______________

Cross –Section Code (for manoes and axes - see illustrations): ____________

Draw Cross-sectional shape (for manos, metates, axes, mauls, adzes and hoes):

Number of surfaces ground:___________

Dimensions of each: Indicate surface ________________ max. length _________ max. width____________ diameter____________

________________ max. length _________ max. width ___________ diameter____________

________________ max. length _________ max. width ___________ diameter____________

________________ max. length _________ max. width ___________ diameter____________

Attach drawing on separate sheet of paper with ground surfaces labeled to coincide with measurements.

Photo numbers:____

Comments:

Definitions for Ground Stone Analysis

Condition:

Complete: artifact is not broken or missing large fragments.

Incomplete: artifact is broken but its original size/shape can be estimated.

Fragment: artifact is broken and its original size/shape cannot be estimated.

Artifact types:

One-hand mano: a circular hand stone with one or more smooth surfaces used for grinding.

Two-hand mano: a rectangular, or oblong, shaped stone used with a slab or trough metate.

Abrader: an irregularly shaped stone with one or more smooth surfaces of variable size. Can also have grooves indicative of use to shape other artifacts.

Pebble mortar: small rock with a basin for confining intermediate substances to be crushed, stirred or pounded with a pestle.

Rock mortar: a larger but still portable rock with a basin pecked into it.

Shaped rock mortar: a rock made into a specific shape with a basin that can vary in size.

Pestle: a cylindrical hand stone of variable size used with a mortar.

Stone disk: a flat piece of stone shaped into a disk. Usually has battered edges and may have been smoothed on both sides of the disk.

Slab Metate: has a flat grinding surface that is not intentionally shaped.

Trough Metate: an intentionally shaped, rectangular metate with a deep basin.

Open Trough Metate: has shaped borders on only two sides and both ends of the trough are open.

¾ Trough Metate: has shaped borders on three sides and the trough is open at one end.

Basin Metate: has a circular grinding surface or elliptical basin.

Open Basin Metate: has a circular grinding surface or elliptical basin this is open on both ends.

¾ Basin Metate: has a circular grinding surface or elliptical basin that is open on only one end.

Pecking stone: a small stone with one or more battered surface(s) used to roughen a grinding surface.

Axe: an oblong, shaped stone ground to a sharp edge on one end and hafted at the other.

Maul: larger, more circular shaped stone hafted at the middle with blunt ends.

Axe/Maul: a fragment of either an axe or maul that cannot be called one or the other with certainty due to the way it is broken.

Other possible ground stone artifact types:

Chopper: a small stone with one edge that has been roughly flaked into a sharp edge.

Adze: an oblong stone shaped similarly to an axe, but hafted perpendicular to the handle; the hafting groove is seen on both of the stone's narrow edges and on only one side.

Hoe: an oblong, tabular stone with grooves only on its narrow edges for hafting.

Tchamahia: similar in shape to a hoe, but made from less durable material like chert.

Fire-drill hearth: a sandstone slab or rock fragment with a small depression that resulted from use with a bow drill

Spindle base: has a larger cupule than a fire-drill hearth with sides that are more steeply sloped.

Whorl: a thin disk perforated in the center to fit over a spindle shaft; the flywheel that maintains spinning momentum of a pump drill. Usually from 4-12cm in diameter and 0.3-2 cm thick.

Material Type:

Use CCAC Field Specimen Codes. (Most common material is sandstone – SND).

Granularity:

Fine:	grains < 1mm in diameter
Medium:	grains 1-2 mm
Coarse:	grains 2-4 mm
Conglomerate:	grains > 4mm

For Vesicular material - Vesicle Size:

Small:	cavities < 2mm in diameter
Large:	cavities > 2mm in diameter

Design:

Expedient: has one or more grinding surface(s) and no other modification.

Strategic: has one or more grinding surface(s) and was pecked or ground into a specific shape.

Use:

Single use: has only one observable function.

Multiple use: designed for a primary activity, but also used for a second activity (e.g. a mano that is polished and flat on one side, that also has grooves on the other for abrading).

Degree of Wear:

Light: can barely be seen with no magnification; has a surface only slightly smoother that the rest of the artifact

Moderate: has an obviously flattened surface, but the rock's shape was not drastically altered

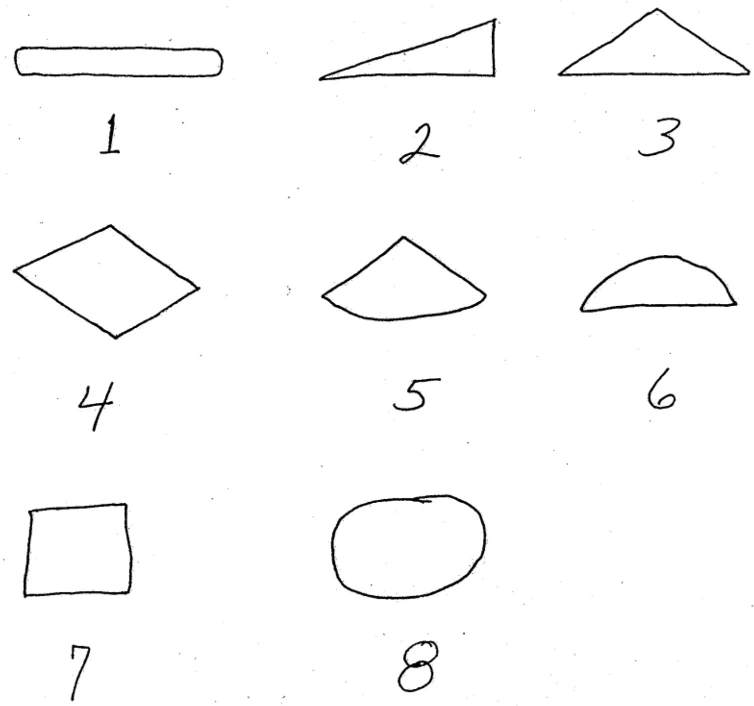
Heavy: has ground or shaped surfaces that changed the natural shape of the rock

Striations on ground surface(s) – Use a hand lens or magnifying glass to decide whether striations are multi-directional or linear, if observable at all.

Measurements: See diagrams below for how to measure artifact and ground surface dimensions. For artifact weight, be sure to indicate units of measurement. Grams or Kilograms.

Crow Canyon Archaeological Center
Mano Size Analysis

Cross-Section Forms and Codes



These codes are meant to illustrate the locations of ground surfaces on a mano.

1: has two opposite ground surfaces worn to a rectangular profile

2: has two opposite ground surfaces worn to a wedge profile.

3: has two adjacent ground surfaces and one opposite ground surface worn to a triangular profile.

4: has four adjacent surfaces worn into a diamond profile.

5: has two adjacent ground surfaces.

6: has a single ground surface and a convex upper surface. (**most common mano type**)

7: has four evenly ground adjacent surfaces; worn into a square profile.

8: has very light wear so the original shape of the stone is not altered.