ANALYSIS OF FLAKED STONE LITHICS

FROM VIRGIN ANASAZI SITES NEAR

MT. TRUMBULL, ARIZONA STRIP

by

Cheryl Marie Martin

Bachelor of Science in Education University of North Texas 1989

> Master of Science University of North Texas 1991

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Cheryl Marie Martin

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Master of Arts Anthropology

Barbara Roth, Committee Chair

Karen Harry, Committee Member

Paul Buck, Committee Member

Stephen Rowland, Graduate Faculty Representative

Ronald Smith, Ph. D., Vice President for Research and Graduate Studies and Dean of the Graduate College

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ABSTRACT

Analysis of Flaked Stone Lithics from Virgin Anasazi Sites near Mt. Trumbull, Arizona Strip

by

Cheryl Marie Martin

Dr. Barbara Roth, Thesis Committee Chair Professor of Anthropology University of Nevada, Las Vegas

This thesis examines flaked stone tools that were used by the Virgin Anasazi and the debitage resulting from their manufacture at six sites in the Mt. Trumbull region in order to infer past human behavior. The behaviors being examined include activities carried out at sites, the processing and use of raw stone materials, and patterns of regional exchange. I have applied obsidian sourcing technology and an analysis of flaked stone attributes. The research indicates a range of activities occurred at habitation sites at Mt. Trumbull, and toolmakers did not need to expend large amounts of time and energy on acquiring their lithic resources. Obsidian, although rare, was not so difficult to obtain or especially valued that it was highly conserved. The inhabitants of Mt. Trumbull obtained their obsidian through a dynamic system of interaction, but from different groups than those from which they acquired pottery, shell, and turquoise.

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CHAPTER 1

INTRODUCTION

This thesis examines a sample of flaked stone tools that were used by the Virgin Anasazi and the debitage resulting from their manufacture at six sites in the Mt. Trumbull region in order to infer past human behavior. The types of behavior to be examined here include general information about activities carried out at sites, the processing and use of raw stone materials, and patterns of regional exchange. A careful analysis of lithic tools and debitage may reveal information about behavioral systems.

I have applied obsidian sourcing technology, an analysis of flaked stone attributes, and previously tested research methods to the lithics from Mt. Trumbull, which is located in the Arizona Strip in the far northwestern portion of the state (Figure 1). Obsidian sourcing, or determining the chemical makeup of individual pieces of obsidian, allows archaeologists to determine the location from which the raw material was acquired (Dixon et al. 1968). The spatial relationship between the source of the obsidian toolstone and the final discard location of a tool provides behavioral information related to the importance of obsidian to the community and how much effort went into acquiring it, as well as patterns of contact between regional groups that may have involved exchange and other types of social interaction.

Previous analyses by archaeologists on the attributes of flaked stone tools and the resulting debitage has provided models through which we are able to identify correlations between lithic assemblage samples and site activities, raw material procurement methods, treatment of different qualities of raw materials, and other behaviors. I have analyzed sample assemblages from six sites near Mt. Trumbull, the results of which have been



Figure 1. Location of the Mt. Trumbull study area.

compared to lithics assemblage models developed by archaeologists over the last 40 years. By identifying similarities to these existing models, it is possible to infer some technological behaviors of the inhabitants of these small villages. The attributes of flaked lithics that have been studied by others are numerous. Examples of those being applied to these assemblages include tool types, the conditions in which the tools are discarded, attributes indicating the stages of production that took place, the texture of the raw materials, and the size and weight of the artifacts.

An analysis of this type has not yet been conducted on flaked lithic materials from the Mt. Trumbull area, and the results of this project add important knowledge to our

concepts of upland Virgin Anasazi archaeology in the area of lithic technology. The results of the obsidian sourcing contribute new information to our understanding of Virgin Anasazi regional interaction systems. Both the obsidian research and the lithic analysis provide data that may be used by future researchers to make cross-site and crossregional comparisons related to Virgin Anasazi trade, raw material use, and site activities.

The flaked lithic artifacts analyzed for this thesis are largely from collections taken during a series of field schools carried out in the Mt. Trumbull area over five field seasons. The project is headed by Dr. Paul Buck of the Desert Research Institute and his assistant Sachiko Sakai from the University of California at Santa Barbara, and primarily funded through Nevada State College. The six sites being studied appear to be habitation sites ranging in architectural features from pithouse depressions to numerous groups of room blocks, although AZ:A:12:214(ASM) may be a series of field houses (Buck, personal communication). The sites possibly range in date from A.D. 500 to 1300 based on small amounts carbon dating, projectile point chronologies, and information from previous site forms. More information is available for each site in Chapter 4. Some of the obsidian artifacts used for the chemical analysis were borrowed from the archaeological repository at Southern Utah University. Details on the borrowed materials are discussed in Chapter 5.

Research Questions

This section serves as an introduction to the research questions in this thesis that have guided the analysis of the lithic assemblages from Mt. Trumbull. The attributes recorded during the analysis were chosen because they have been found by other researchers to

possibly relate to behavior at other archaeological sites. This previous research is briefly addressed below, and discussed in more detail in Chapter 2.

In order to learn about behavior at Mt. Trumbull related to flaked stone tools, I have applied the results of two types of analysis: 1) obsidian sourcing, and 2) flaked stone analysis. Research on flaked-stone tool production and the use of tools is a component of studies on technological organization (Nelson 1991). These studies are important because they allow us to make inferences about the activities of past cultures and reveal how populations solved problems created by both their physical and social environments (Carr 1994). The physical environment in which the Virgin Anasazi lived limited their access to only certain types of stone tool materials and affected their decisions about the types of tools they would produce. Access to resources outside their region had to be negotiated through social and economic relationships. The research questions assist in identifying the types of materials the Virgin Anasazi had access to, how they put them to use, and how they obtained toolstone that was not immediately available to them.

Unfortunately, the long-term occupation of sites at Mt. Trumbull and the limitations on excavations and carbon dating during field schools make it difficult to compare sites temporally. Therefore, the research questions focus on behavior at the sites in general, without reference to change over time.

1. What do the tools and debitage from the assemblages reveal about how people lived at Mt. Trumbull?

Results of the lithic analysis conducted for this thesis show us which raw materials were chosen for making tools, which stages of production took place at the sites, and to what extent tools and other lithics were utilized. The types of debitage indicate which stages of tool production occurred at sites. The presence of cores and early stage debitage is representative of inhabitants bringing material into the site in a relatively raw, unworked form. Where tools are common without cores and early-stage debitage, the data suggest flakes for tools were produced elsewhere and carried to the site. The latest stages of debitage imply formal tools were produced and maintained on site. Data related to formal versus informal tool use may suggest how easily raw material could be accessed and whether tools were produced to be used on or off site. Difficulty accessing toolstone and the need to carry tools over long distances are two of the variables that have been associated with the production of formal tools. The relative number of tool types among sites tells us if similar activities occurred at each. The attributes recorded during this analysis that provide data to answer this question include measurements related to size, flake portion, production characteristics, modification and use-wear characteristics, and tool types.

A single tool type may be used for multiple activities. As such, the numbers of tool types and related debris have been compared between sites to interpret the variety of activities that may have occurred, rather than attempting to identify the activities themselves. As the sites studied for this thesis are similar in architecture, they may also be similar with regard to the activities that took place. It should be noted that artifact class richness may be highly affected by sample size (Jones et al. 1983), and the number of tools in the Mt. Trumbull assemblage is relatively low.

2. Was higher quality chert used differently than other cherts?

Cherts of various qualities were readily available to toolmakers at Mt. Trumbull. I have analyzed chert-use patterns to determine if the people at Mt. Trumbull tended to conserve the higher quality sources. Toolstone conservation provides information on how the local inhabitants viewed their ability to access raw materials. This behavior is inferred through a variety of patterns. Formal tools are associated with conservation, in that a tool of higher-quality material, particularly if the material is difficult to access, may be designed to last longer or perform a wider range of tasks than an informal tool. The later stages of debitage are also associated with conserving material, since a tool of a more valued stone was likely to be resharpened to extend its uselife, perhaps to the point that the tool was exhausted. The presence of large, unused flakes of a certain toolstone suggests it was not conserved. At Mt. Trumbull, low numbers of unused flakes of the higher quality material would imply it was used in a more conservative manner.

The degree to which a flake was modified or used may also indicate efforts to preserve material. Where flakes of higher quality toolstone have more modified and/or utilized edges than flakes of other raw material types, the implication is that the higher quality stone was a preferred material for tools of that type. The attributes used to address this question include material texture, size, modification and use-wear evidence, and tool types.

3. With whom (geographically) did the Virgin Anasazi of Mt. Trumbull interact to acquire obsidian?

Archaeologists have identified an extensive network of Virgin Anasazi mobility and exchange through the study of pottery, shell, and turquoise. The most extensive evidence for interaction shows contact between the upland and lowland Virgin groups, to the extent that some archaeologists do not concur on whether the same people inhabited both environments during different seasons or climate periods, or if exchange took place between fairly sedentary populations living in each of the different landscapes contemporaneously. There are also indicators of long-distance economic relationships with groups producing shell items on the western coast of California and copper in Mexico. Interaction between nearby cultural groups, such as the Fremont to the north and the Kayenta to the east may have also occurred, perhaps based on more familial-type relationships. The Virgin Anasazi trade system is discussed in more detail in Chapter 3.

The research question in this thesis related to the acquisition of non-local goods by those at Mt. Trumbull is addressed through the chemical sourcing of obsidian artifacts. The only published information on obsidian sourcing of materials found in or immediately adjacent to the Arizona Strip comes from two articles (Lesko 1989; Nelson 1984), in which the sources were identified at locations in Utah and south of the Grand Canyon in Arizona. I have sourced most of the obsidian that has been collected during the Mt. Trumbull project's 2001–2006 seasons, as well as that collected during previous surveys east of Mt. Trumbull in the 1970s. It is reasonable to conclude that the Virgin Anasazi had regular contact with people who lived in, or traveled to, the regions from which the obsidian originated. A description of the obsidian sourcing methods used for

this thesis and the results of the testing is presented in Chapter 5. The sourcing data will increase our understanding of regional exchange behavior beyond that which has formerly been inferred through the movement of shell, turquoise, and pottery.

4. Is obsidian treated as an exotic material at Mt. Trumbull?

Exotic toolstones refers to materials that were difficult to access. Often the difficulty lay in the distance the material source was located from the site. Also related to distance was the relative degree of mobility the site inhabitants engaged in. Groups that moved around frequently as part of a mobile subsistence pattern were more likely to have access to distant materials, while more sedentary people would have depended on other means, such as trade or occasional long-distance forays, to acquire exotic toolstone. Other obstacles to resource access could have included geological barriers and resources that were controlled by other groups. The research area is, in fact, bounded on the south by a very famous geological barrier -- the Grand Canyon. Since the obsidian found at Mt. Trumbull is known to be non-local, it is expected to meet the predictions suggested by archaeologists for exotic raw materials, in which case obsidian artifacts would be in a more reduced state, be in the shapes of formal tools, or the refuse from maintenance and recycling of formal tools. These are the same characteristics that were discussed above in the research question related to higher quality toolstone, as exotic material is expected to have been highly conserved. The predictions are considered further in Chapter 2. The attributes used to address this question involve tool type, flake stage, and the obsidian sourcing results.

This thesis is organized into six chapters. Chapter 2 discusses previous work conducted by researchers that may be applied to the results of the Mt. Trumbull analysis to establish some of the behaviors of the people who lived there. Chapter 2 also addresses formation processes and their contributions to understanding sites as they are found in the Mt. Trumbull environment. Chapter 3 provides background data, summarizing previous research on the Virgin Anasazi with regard to typical site architecture, artifact types, evidence of trade, chronological models, and surveys that have been formerly conducted in the Mt. Trumbull area. Chapter 4 describes the methods used to select the lithic samples for analysis, the attributes recorded, and the characteristics of the sites from which the samples were collected, as well as the results of the flaked lithic analysis for each site. Chapter 5 presents the methods and results for the obsidian sourcing study. In Chapter 6, a summary of the findings is provided, and the research questions are each addressed in detail, followed by the conclusions.

CHAPTER 2

ESTABLISHING AN INTERPRETIVE FRAMEWORK

This chapter examines the work previously conducted by archaeologists that relate to the topics discussed in the research questions: an interpretation of site activities with regard to lithic production stage and relative frequencies of site activities, the use and treatment of raw stone material, and patterns of interaction for the purposes of acquiring exotic toolstone. The evaluation of inferences depends on the connection between what is observed in the archaeological record and the conditions that created the assemblage. Strengthening these inferences requires the development of "reliable and operationally independent measures" of these connections (Amick and Mauldin 1989). Archaeologists have designed and tested a number of middle-range theories to connect the findings at archaeological sites with behaviors of the human inhabitants. The characteristics of tools, debitage, and raw material may be counted, measured, and described in order to infer some information about how people lived and adapted to their environments. Below I discuss the lithic attributes that have been recorded for the Mt. Trumbull analysis in the context of some of the studies and experiments conducted by previous researchers in order to make the connection between the flaked lithics found at Mt. Trumbull and Virgin Anasazi behavior.

Prehistoric tool production differed according to the available materials, the type of tool desired, the individual toolmaker, and a number of other variables based on the environment and conditions at the time. Tool producers made their tools in a logical progression, but would not necessarily have followed any particular step-by-step process for making a tool. The attributes of lithic materials and stages of production are terms

that archaeologists have created to more easily categorize and discuss the production process. Those attributes which are discussed in this thesis in the context of flake analysis are the material type, texture, cortex, platform type, platform lip, dorsal flake scars, size, weight, and the proximal (platform) end and the distal (terminating) end of the flake.

The process usually began when a flake was removed from a core. A flake that was used as a tool without any further modification is referred to as a utilized flake. If additional work was done on the flake to modify one or more edges, it is called an edgemodified or retouched flake. A formal tool is the general term often used in this thesis to refer to bifaces, drills, and projectile points as a group. A biface is a tool with two surfaces that meet to form a single edge, and has flake scars that travel across the surfaces of both sides. Drills and projectile points are also types of bifaces. The additional modification of flakes into tools resulted in smaller flake removals, which usually had the purpose of thinning and shaping a tool. Once a tool had been used or broken, more flakes may have been removed to rework the edge into the desired form again or to turn the tool into a completely different type of tool.

This general process resulted in the flaked stone lithic assemblages that are recovered from archaeological sites. Specialists in lithic technology have also published more detailed descriptions of flintknapping than that which has been provided here (Andrefsky 1998; Whittaker 1994).

Platform Attributes

The platform attributes recorded during the analysis of the Mt. Trumbull assemblage were platform type (simple or complex), presence or absence of grinding, and presence or absence of a lip. Studies that have related these attributes to behavior are discussed here.

Tomka (1989) and Odell (1989) both noted that core reduction activities are more likely to result in single-facet platforms than biface reduction work, the latter of which would have a higher percentage of small flakes and platforms with evidence of grinding and faceting. Single-facet platforms have also been associated with early to middle stage reduction by other researchers (Teltser 1991; Tomka 1989). Morrow (1997) found striking platform abrasion to be especially associated with "refined" biface-thinning activities. Where the raw material source is usually in the form of cobbles with a weathered outer cortex, flakes with cortex platforms occur more often in the early stages of reduction (Teltser 1991).

In handaxe production experiments, Newcomer (1971) noted that hard hammer percussion, commonly associated with early-stage core reduction, resulted in bulbs that were immediately adjacent to the platform. Soft hammer percussion, used for late-stage production, more often resulted in platforms with lips and a bulb that began below the lip (Frison 1968; Hayden and Hutchings 1989; Newcomer 1971).

Cortex

Cortex is more likely to be present on flakes resulting from early-stage reduction (Mauldin and Amick 1989; Odell 1989), however a number of other variables may also affect the presence or absence of cortex in a lithics assemblage (Dibble et al. 2005). The

behavioral variables include the amount of cortex that is removed from the cobble prior to the start of flake removals for the purpose of making tools and whether these removals occurred on or off site, the intensity to which a nodule is reduced at the site, and the materials that are carried off the site after tool production has occurred. The size and shape of the nodule are also factors. As the size of a nodule increases, the interior mass increases more than the exterior surface area, such that a small nodule would have a higher average amount of cortex per volume than would a large nodule. With regard to shape, the surface area of a spherical nodule would be less than that of an elongated nodule of the same volume. In addition, the amount of cortex found in an assemblage will be affected by the characteristics of the objective piece (Andrefsky 1998). For example, a piece of chert that has been chipped off of a boulder to be used as a core many not have any cortex on it at all. Despite these issues, the presence of cortex in the assemblage does still *usually* reflect early stage reduction (although cortex can be present on late-stage debitage), and can be added as one of the means to place an artifact within a reduction stage.

Flake and Tool Size

Newcomer (1971) found that given the use of similar reduction techniques and materials, flakes became smaller on the average as his three-step production process progressed from the first to third stages. The common association of early-stage reduction and larger flakes has also been noted by several other researchers (for example Fladmark 1982; Odell 1989; Stahle and Dunn 1982); however, small flakes may result from all stages of reduction (Magne 1989). In addition, the percentage of large flakes in

an assemblage may have been reduced by the selective removal of flakes for production into tools (Magne 1989; Mauldin and Amick 1989).

Henry (1989) discusses methods through which the assemblage may be used to determine toolmakers' behavior related to the location of tool production and the efficient use of raw material sources. He looks at the smallest complete tool size in comparison to complete unmodified flakes. Where unmodified flakes are larger than the smallest tool, tools were more likely to have been made on site rather than be brought to the site in finished form, and there does not appear to have been a desire to conserve raw material.

Flake Portion

The attribute of flake portion has been studied as a possible indicator of early versus late-stage production. Flake portion, however, has proven difficult to pin down in relation to stage. For example, Tomka (1989) has found broken flakes to be more commonly associated with core reduction, but Sullivan and Rozen (1985) associated broken flakes with late-stage tool production. It should also be noted that different raw material types have dissimilar fracturing qualities, which may affect flake portion and frequency of shatter independently of the toolmaker's behavior (Amick and Mauldin 1997). My own efforts to evaluate the affect of toolstone on flake portions in the Mt. Trumbull assemblage ran into additional difficulties, which are discussed in the methods section of Chapter 4. Due to these complications in applying flake portion as a line of evidence to interpret production behavior, the attribute has been reported in the results section for each site, but was not considered in the interpretations for this project.

Dorsal Flake Scars

The number of flake scars on the dorsal face of a flake has also been theorized to have an association with its stage within the tool production process. Flakes with low numbers of dorsal flake scars are more likely to have been produced during the early stages of core reduction, while higher numbers of flake scars are thought to be associated with later processes such as biface reduction (Bradbury and Carr 1999; Magne 1985, 1989; Odell 1989). Mauldin and Amick (1989) noted that flakes removed during the first and second stages of their four-step experimental process averaged less than three dorsal flake scars per flake, and flakes removed during the latter part of the process averaged over three scars, but the overall relationship was weak as flake size, core size, and reduction strategy also affect scar counts. Shott (1994) noted that when using scar count as a variable, it was preferable to correct it for size. Statistical models have also been developed to help infer reduction stage using dorsal scar counts (Bradbury and Carr 1999; Carr and Bradbury 2001).

Formal vs. Informal Tools

The relative frequencies and types of formal versus informal tools provide clues to the activities that occurred at a site and to behaviors related to toolstone use. As to raw material availability, informal tools tend to coincide with an abundance of raw materials, and formal tools with a low availability of quality toolstone. It should be noted, however, that other variables, such as mobility, tool function, the tasks to be performed, etc., also impacted decisions to make formal or informal tools.

Bifaces and other formal tools were multifunctional because the general forms could be adjusted for a number of tasks, and they could be resharpened for multiple uses (Parry and Kelly 1987). Odell found several types of use wear on all bifaces examined from an Illinois Valley assemblage, indicating they had been utilized with a variety of motions and on different types of materials (cf. Odell 1996a). Bifaces could also be used as cores from which additional flakes would be removed and offered a relatively durable sharp edge over the long-term use of the tool (Kelly 1988). These characteristics made formal tools beneficial when a task came up unexpectedly, especially away from the base camp (Bamforth 1991). Prehistoric people made formal tools such as bifaces for activities that would have occurred away from the residence such as hunting (Bamforth 1991; Binford 1979; Keeley 1982). In Bamforth's terms, the reliance on hafted bifaces while being away from the main site "can be understood as a solution to the relatively high spatial and temporal unpredictability of many tasks carried out away from residential bases and the need to minimize the amount of gear carried."

The drawbacks of formal tools include the time involved in training, manufacture, and maintenance, the need for good-quality material, and the dulling of the edges as the items were retouched (Parry and Kelly 1987). Informal, or expedient, unprepared tools could be quickly created in response to a situation where a tool was needed (Binford 1979).

The use of formal tools has been connected to the need to conserve lithic raw material. In Jeske's discussion (1989), bifaces are advantageous when a raw material type is scarce because they offer more cutting edge per unit of stone and can easily be resharpened. In a similar vein, Parry and Kelly (1987) note that where raw material is

readily available and can provide the sharpness of edge needed for the tasks that need to be undertaken, there is little need for formal tools. Morrow and Jeffries (1989) discuss the types of artifacts that would likely be recovered at a site where exotic raw material was used, in which case artifacts made of these rare toolstone types would be in the shapes of formal tools or the refuse from maintenance and recycling of formal tools, and the tools would have been largely exhausted before discard. Odell (1996b) uses the relative frequency of biface thinning (late stage) flakes to infer how often formal tools were resharpened and suggests that a higher frequency indicates an effort to conserve those particular raw material types. While these pattern predictions tend to be found in most cases, there are exceptions. MacDonald (2008) discovered that while non-local materials were more often used for formal tools at a site in West Virginia, they were also preferred for informal tools, although a lower quality chert was locally available. He concluded that other variables had an impact on the choice of raw material beyond the cost involved in using the non-local material.

Inferring particular activities from formal and informal tool types has its difficulties. Ahler discovered that projectile points may have been used not only as the tips of spears, darts, or arrows, but also for cutting, butchering, slicing, sawing, whittling, scraping, splitting, or piercing (c.f. Odell 1981). Odell found that side scrapers could be utilized for scraping, graving, cutting, chopping, or as projectiles. In addition, Frison discovered that two tools which appear different in morphology could have been used for the same purpose, but were in different stages of rejuvenation. He also discovered that evidence garnered from the refitting of retouch flakes could change the interpretation of how a tool was used (Frison 1968). Of the types of tools that Odell tested for use wear that are also

present at Mt. Trumbull, only burins could be predicted to have been used primarily for boring or perforating, although other uses were still identified (c.f. Andrefsky 1998; Odell 1981). In fact, Young and Bamforth (1990) have shown that use wear analysis without intense magnification can be inaccurate, and Odell also discourages the use of macroscopic analysis to determine causes of use wear due to unreliability (personal communication). Due to the difficulties in identifying the precise use of a tool, there has been no effort to determine a tool's function for this thesis. Rather, the tools general morphological category has been classified, or the simply the presence or absence of modification or use wear.

Regardless of the activities that resulted in their presence at a site, formal and informal tools tend to have certain patterns in the context of the archaeological record. Informal tools tended to be used unhafted (Bamforth 1991). Gould's Australian ethnographic research (1971) showed that hand-held tools, such as unmodified flakes used for butchering and scraping wood, were more likely to accumulate at the location of their use; therefore a site at which utilized flakes were put to use should still contain those tools.

Broken Tools

Broken, hafted tools, such as projectile points and bifaces, tended to accumulate at the location at which they were replaced in the hafts, rather than where they were last used. A long-term residence would be more likely to include broken hafted tools that were replaced after an off-site activity group, such as a group of hunters, had returned to a home base (Bamforth 1991; Keeley 1982). Binford (1979) reported the Nunamiut would

go through their toolkits while at home and discard tools that were no longer usable and make new ones from cached toolstone.

Keeley (1982) refers to work done by Robertson in which the distal ends of projectile points may have been deposited at base camps when they were removed from meat. Therefore the presence of the proximal and distal ends of projectile points may indicate separate types of activities.

Intensity of Use

Where raw material is scarce and minimal amounts of toolstone are available for scavenging, tools made from rare materials are more likely to be reworked, resulting in a higher proportion of late-stage debitage found in the assemblage (Magne 1989). Bamforth (1986) found that while settlement patterns may have an impact on the type of technology used (i.e., formal versus expedient), a toolmaker would be less likely to rejuvenate a dull or broken tool if high quantities of usable material were available to craft a new one. His research showed tools made from distant raw material sources were more likely to be retouched (indicating maintenance). Barton, in a study that looked at types and intensity of retouch on flakes (1990), found an association between sites where lithic resources would have been more difficult to replenish and higher levels of retouch. MacDonald (2008) also found a relationship between more intensive use/retouch and nonlocal raw materials. For this thesis, how intensively a tool was utilized was determined by the number of modified or worn edges (functional units) on a single stone tool. To study how efficiently toolstone was used, the smallest complete tool size was compared to unmodified complete flakes, in the manner suggested by Henry (1989).

Cores

The types of cores in a lithic sample can reveal information that addresses several behavioral patterns. One common type of core is referred to as amorphous (also called informal). Patterson (1987) defines these as cores that lack a formal standardized morphology. They can result from a number of manufacturing situations. Studies have associated amorphous cores, as opposed to standardized cores, with raw material that is abundantly available and/or found in large sizes (Johnson 1986). According to Kelly (1988), a high incidence of informal cores indicates that residents at a site did not depend on bifaces for the production of flakes.

Two types of cores have a more standardized or formal morphology. Bifacial cores are often disc-shaped with two faces that meet in an edge, and unidirectional cores have flakes removed in one direction and have a single striking platform (Andrefsky 1998). Another type of core, bipolar, is the result of placing the core on a type of anvil and striking it with a hard hammer. Bipolar reduction has been related to the need to conserve lithic materials or to cores that are too small to reduce using the hand-held method (Andrefsky 1994).

Although amorphous cores have been associated with an "unstructured" technology (Johnson 1986), research shows that a technology in which the goal was to produce unmodified flakes for use as tools may have had "highly flexible reduction trajectories in terms of the behaviors that produce them, the sequence and context in which those behaviors are performed, and, perhaps most importantly, the products that are created" (Teltser 1991).

Formation Processes and the Mt. Trumbull Environment

Formation processes refers to the modeling of laws or "transformations" related to the changes that artifacts undergo from the point at which materials are gathered to make them to the time archaeologists find them. By developing these laws, it is possible to break down changes to artifacts into units that are easier to define and explicitly apply to each individual assemblage. Artifacts have been affected by both cultural and noncultural formation processes. Correlates, such as experiments or tests, help establish relationships between hypothesized behavior and transformations (Schiffer 1975).

Cultural formation processes involve how artifacts were procured, produced, used, maintained, and discarded by their prehistoric users. The manner in which items were transported, stored, and reused is also a factor (Schiffer 1972). With regard to lithics, procurement refers to collecting the raw material for tool production. When a flaked stone tool was produced, the debris may have become part of the record at that point, or perhaps been collected and discarded in a refuse pile. A flake may have continued on in the process and been used as a tool either in its unchanged form or after having undergone further alteration. A tool may have been used only once, or it may have been resharpened or modified into a tool designed for another function. Schiffer defines reuse as "a change in the user or use or form of an artifact, following its initial use." Reuse would have transpired when a task was finished, or when a tool broke, became worn out, or for any other reason could not carry out its function. Some of the methods of reuse involved the change of the artifacts user without a change in the form or function of the artifact, and recycling, which changed the function of the object from its original intended use (Andrefsky 1998; Schiffer 1996). An item could also be stored for later use

or transported to another location. Once the tool served its purpose, it was discarded, either intentionally or unintentionally. It may have been dropped where its final use occurred or purposefully discarded in a refuse location (Schiffer 1972). A tool may also have been scavenged by another and reused (Schiffer 1975), or lost or stored but not recovered by a user.

The cultural formation processes and correlates that have been developed by archaeologists and other scientists have been applied to the Mt. Trumbull assemblages to link the results of this lithic analysis to behavioral patterns.

At the point in which the artifact is no longer affected by the prehistoric user, and assuming it is not further affected by another individual at a later time, it continues through a series of processes before it becomes part of the archaeological record. Many possibilities remain for further change of the artifact's condition and location before it is recovered by an archaeologist. These natural impacts include the modification or destruction of artifacts by chemical or physical events, final locations in which artifacts are found, the relationship of artifacts to each other in space, and the physical environment in which they are located (Schiffer 1975).

To discern which types of natural formation processes are relevant to Mt. Trumbull, it is necessary to understand its physical environment. The area is made up of eroding basalt hills and mountains, having a climate that brings large amounts of snow in the winter and heavy rain storms in the summer which generate water flow through drainages and washes throughout the vicinity. Otherwise water is present on an ephemeral basis through springs and seeps. The water table levels in the Colorado Plateau are known to have risen and lowered a number of times between A.D. 1 and the present, indicating

increases and decreases in moisture levels. Vegetation is heavy, made up of cacti, shrubs, and trees native to a Southwest pinyon-juniper zone, and has been the primary species type in the area since at least 3400 B.P. (Altschul and Fairley 1989). The sites described in this thesis are at an elevation range of about 6,100 to 6,200 ft above mean sea level. Larger sites are located primarily on flat or gently rolling areas on the sides of hills. For these and other reasons discussed below, the locations in which artifacts are found are affected by a number of natural formation processes.

A major factor in the movement of artifacts included in this thesis is erosion related to slope and gravity. If other variables are held constant, when water and wind impact a site having an elevation gradient, some artifacts will move downhill away from their original locations of deposit (Schiffer and Rathje 1973). Artifacts at Mt. Trumbull were frequently found spread along the sides of hills below the architectural component of each site, and, in the small valleys between the hills, artifacts from different sites were mixed together. Although some research has been undertaken to measure how far objects may shift down a slope over time, the numerous variables involved make it extremely difficult to predict an artifact's movement. Some of the natural processes related to slope are discussed next.

Rick (1976) defined erosion related to archaeological artifacts as "a downward movement of cultural material, the impetus for which is provided by gravity, precipitation, wind, streams, oceans, or such organic forces as plants and animals." In his study of artifacts at Ccurimachay in Peru, where slopes ranged from less than 10° to 44°, vegetation, in this case grasses, held artifacts in place which might have otherwise moved downslope. In the Mt. Trumbull area, sites may be on open low-sloping hills with heavy

desert brush vegetation on sandy soils, or on steeper slopes among pinyon-juniper vegetation. In the pinyon-juniper zone, there is less vegetation low to the ground. Rather, there is more decomposing tree materials, alternating with eroded basalt ranging in size from sand to boulders. Since humans first lived in the area, bushes and trees at the sites have been purposefully cleared by inhabitants or come and gone as part of their natural life cycles, and new flora has regrown over the area many times over. Mills (1986), in a study on the movement of large clasts on forested hillslopes in Virginia, noticed forest litter was greater on north-facing slopes in comparison to those southfacing, and that the litter could impede the movement of clasts directly and also by reducing "the amount of expansion/contraction by decreasing the amplitude of changes in soil moisture and temperature." In addition, the loss of forest litter due to fire has been shown to increase surface sediment movement on hillslopes by as much as three times (Morris and Moses 1987; Wandsnider 1989). Environmental management practices such as cabling and herbicidal treatments in pinyon-juniper zones also lead to higher rates of soil disturbance (Lopes and Ffolliott 2001). The degree to which vegetation, or the lack of it, at Mt. Trumbull sites has promoted or inhibited the movement of artifacts is impossible to measure, but is likely to be considerable.

Formation processes have been discussed here to emphasize how artifacts at an archaeological site may be affected prior to their collection for analysis. These processes have the potential to impinge on the accuracy of the interpretations made in this thesis. For the purposes of comparing the sites, the assumption is made that artifacts were found at the sites at which they were last used, but with the understanding that they have moved

substantially from their original locations of cultural deposit within the site unless otherwise noted.

This chapter has summarized some of the previous theories that have been developed with relation to flaked lithic analysis and site formation. With the knowledge of the work that researchers have conducted in the past, it is possible to apply what has been learned to the Mt. Trumbull lithics assemblage to interpret some of the behaviors of the people who lived there. Interpretations of behaviors on a site by site basis are provided in the summaries at the end of the lithic analysis results for each site in Chapter 4. Chapter 6 discusses behavioral interpretations in the context of the research questions for Mt. Trumbull as a whole.

CHAPTER 3

BACKGROUND INFORMATION

This chapter provides a description of previous research on the Virgin Anasazi. The information here pertains to characteristics of the cultural group in general, a summary of an excavated Virgin Anasazi site located near Mt. Trumbull, particular work that has been conducted in the Mt. Trumbull area, and a description of what is currently known about the movement of trade items through the Virgin Anasazi region. Following the information on the Virgin Anasazi is a discussion on formation processes and the method of using laws and correlates to better interpret behavior from archaeological data.

The Virgin Anasazi

The Virgin Branch of the Anasazi people, or far western Anasazi, occupied the Three Corners area of southeastern Nevada, southwestern Utah, and northwestern Arizona, bounded on the east and south by the Colorado River (Figure 2). In Nevada the Virgin Anasazi inhabited the area around the Virgin and Muddy Rivers, and in Utah they lived in the St. George Basin and extended northeast to beyond the Escalante River (Lyneis 1996). They inhabited both desert and upland environments and practiced a subsistence strategy that included hunting and gathering and farming. Elevations in these areas range from 7000 ft in the Arizona Strip to 1150 ft at the Virgin and Muddy Rivers (Ezzo et al. 1996; Lyneis 1995). Cultural groups surrounding the VirginAnasazi included theKayenta Anasazi to the east, the Fremont to the north, mobile groups to the west, perhaps the precursors to the Southern Paiute, and the Patayan to the south (Ezzo et al. 1996; Lyneis 1995).



Figure 2. The Virgin Anasazi region and other locations discussed in this thesis. Adapted from Lyneis 2000.

Chronological periods for the Virgin Anasazi are centered around the Pecos Classification, which was developed for the Anasazi of the Four Corners region during a conference held in 1927. A number of archaeologists who work in the Virgin Anasazi area use similar chronological divisions published by Fairley (Altschul and Fairley 1989). These divisions are Basketmaker II (start unknown, but at least by 300 B.C. - A.D. 400), Basketmaker III (A.D. 400 - 800), Pueblo I (A.D. 800-1000), Early Pueblo II (A.D. 1000-1050), Late Pueblo II (A.D. 1050-1150), and Early Pueblo III (A.D. 1150-1225). More recently, Allison (2000) recommended that Early Pueblo II begin at A.D. 950, and Late Pueblo II end at A.D. 1175, which extends the Pueblo II period to a total of 225 years.

Maize and squash farming marks the beginning of the Basketmaker II period (?300 B.C. - A.D. 400). People in the Virgin Anasazi regions of the St. George Basin and on the Colorado Plateau lived in pit houses with minimal floor features and in rockshelters. Storage generally consisted of semisubterranean, slab-lined, circular, storage features referred to as cists. In the lowland areas, primarily in Nevada, pit structures occurred in groups of one to five and had fire hearths and clay floors, but were rarely accompanied by cists. Artifact types associated with this period include sandals, coiled baskets, fiber and hide bags, dart foreshafts, atlatls, snares, nets, cordage made from human hair, and rabbit fur blankets (Altschul and Fairley 1989; Lyneis 1995).

Pit houses and groups of non-contiguous, circular, slab-lined storage cists continued to be the norm during the Basketmaker III period (A.D. 400 - 800), and ceramics, trough metates, and the bow and arrow came into regular use. The pit structures tended to have benches and to be slab-lined, with shallow antechambers. Diagnostic ceramic types for the period are Lino, Boulder, and North Creek plain gray, sand-tempered pottery and gray wares painted with Lino-style designs in carbon paint (Boulder Black-on-gray and Lino Black-on-gray). Although red wares were being produced during this time in the Kayenta and Mesa Verde areas, they were not yet being imported to the Arizona Strip. Ceramic vessel types were dominated by large, long-necked ollas and hemispherical bowls. Moapa gray ware, which was generally made near Mt. Trumbull, the known source of its olivine temper, was present in the Moapa Valley by this period (Altschul and Fairley 1989; Dalley and McFadden 1985; Lyneis 1995, 2000).
Pueblo I (A.D. 800-1000) is characterized by the construction of deep, oval, carefully chinked and clay-sealed storage rooms or cists with low courses of masonry. They were sometimes built contiguously and often into an arc shape. Pit houses continued in use, with the addition of a central fire hearth, several shallow subfloor pits, and a ventilator in some cases, but lacking antechambers. Benches and slab-lined walls were still common, but seemed to be optional. The dwelling and storage-room arc began to be built into a pattern that defined an outdoor living space (Dalley and McFadden 1985). Although the architectural patterns of this period tended to be similar, there was quite a bit of variation in site layouts, including some habitation rooms built into the storage room arc and many variants of the architectural attributes listed above. A new ceramic vessel type, the globular jar with a long, flaring neck, emerged during the Pueblo I period, as well as the indigenous pottery types of Washington black-on-gray, Boysag Black-on-gray, and, later in the period, St. George Black-on-gray. There is some indication that upland sites began to be inhabited during the winters to maximize subsistence output and resources such as fuel and water. Stored resources would provide food through the season, wood was abundantly available, and melted snow would have been a constant source of water. After the winter supply of stored foods had been exhausted, groups could move down to valley bottoms for the newly available plant resources. The model whereby the Virgin Anasazi lived in the lowlands during the winters and the uplands during the summers also remains plausible (Altschul and Fairley 1989).

During the Pueblo II period (A.D. 1000-1150), habitation rooms were built in a variety of styles: subterranean, semi-subterranean, or on the surface, and either attached to a contiguous room block or separate. McFadden (1996) suggests the incorporation of

the habitation room into the contiguous room block could be the result of Kayenta influence from the east side of Kanab Creek during the Pueblo II period. Pit structures built during the time usually had benches, optional slab-lining, a ventilator/small antechamber configuration on the southeast side, and a formal floor plan. Storage rooms became more shallow and rectangular, but were built contiguously in shapes ranging from a slight arc to a "C" arrangement, frequently open to the southeast. In some areas storage rooms had full masonry walls. Sites tended to be small, with only one pit structure and a few storage rooms, although sites with up to 30 rooms are present, with many reported having around a dozen rooms or so. Although kivas were common among eastern Anasazi groups, they are encountered only rarely in the Virgin Anasazi region, and close enough to the Kayenta boundary to have perhaps been built by members of that cultural group (Altschul and Fairley 1989; Dalley and McFadden 1985; Lyneis 1995). Between A.D. 1100 and 1150, there is some architectural evidence in the Moapa Valley suggesting a possible shift to communal storage. At Mesa House storage space averaged 12.5 m2 per habitation unit, which was substantially larger than the average storage area found at earlier sites. These results may indicate the emergence of multifamily corporate groups in the lowland Virgin Branch area (Lyneis 1986).

Altschul and Fairley (1989) discuss a wide variety of subsistence/settlement models that have been proposed for the Virgin Anasazi during Pueblo II, varying from seasonal mobility to substantially sedentary, as well as several reasons for these patterns, ranging from environmental and horticultural changes to cultural preferences. There was an increase in the number of sites during the period, with virtually all areas near arable land being inhabited. In upland areas check dams and scattered terraced garden plots began to appear. Painted pottery types that appear during this period include North Creek Blackon-gray, Hurricane Black-on-gray, Virgin Black-on-gray, Mount Trumbull Black-ongray, and Moapa Black-on-gray, and late in the period, after A.D. 1100, Washington Corrugated and Nankoweap Polychrome. The corrugation of jar and bowl exteriors is an important characteristic for Pueblo II (Altschul and Fairley 1989).

Sites are rarely reported in the Virgin Anasazi area for the early Pueblo III period (A.D. 1150-1225) and later. Work at the Pinenut site resulted in radiocarbon dates from early Pueblo III (Westfall 1987), and at Quail Creek, nine radiocarbon tests from six sites resulted in dates from early Pueblo III and later, although the authors considered many of these aberrant dates (Walling et al. 1986). Some sites also contain ceramics that are known to have been made in the Kayenta area during Pueblo III years, such as Flagstaff Black-on-white and Tusayan Polychrome. These findings and others indicate the likely habitation of at least some sites in the Virgin Anasazi area after A.D. 1150. There is some indication that horticultural intensification was occurring during this period on the Walhalla, Powell, and Kanab plateaus, in the form of ceramic evidence and associated agricultural features. East and south of the Arizona strip check dams and irrigation systems were increasing during early Pueblo III. The reason for intensification may be related to environmental changes and/or population pressure (Altschul and Fairley 1989). Larson's research suggests that the population of the Muddy and Virgin River areas increased fourfold between A.D. 800 and 1150. Population size and density pressure caused the Virgin Anasazi to become progressively more reliant on agriculture, and, during the times of highest population pressure, they appeared to place their settlements

in areas where check-dams and canal irrigation methods would operate the most productively (Larson 1996).

The theories vary on when and why the Virgin Anasazi abandoned the area. The most popular explanation centers around changes in the environment that reduced the amount of food that could be produced. Another possibility is the arrival of the Southern Paiute, referred to as the "Numic spread." Abandonment dates are postulated from as early as A.D. 1150, but no firm date has been established (Altschul and Fairley 1989).

During the Virgin Anasazi period overall, pit houses and the requisite slab-lined, clay-sealed storage facilities were most common, which has been referred to as the "core" of Virgin Anasazi sites by Dalley and McFadden (1988). In favorable geologic locations rockshelters and cliff dwellings were occasionally occupied. Most small sites are thought to have been inhabited by one or two families, with larger sites perhaps housing three to five. Unlike Anasazi sites to the east, rooms built entirely out of carefully fitted-stone masonry have not been identified in the Virgin Anasazi area, and there is little evidence thus far that these groups built any other type of substantial permanent architecture. An example of a large settlement by Virgin Anasazi standards would be Main Ridge in the Lower Moapa Valley, which was originally described by Mark Harrington in the mid-1920's as a cluster of 44 "houses" made up of 203 rooms (Lyneis 1995, 1996).

Whereas, archaeologists tend to associate pit houses with more mobile groups and surface pueblos with increased sedentism, this pattern does not appear to reliably occur in Virgin Anasazi communities. McFadden (1996) noted that in both the St. George Basin and the Utah uplands, early pit house occupations (AD 300 - 1050) and Late Pueblo II room blocks (AD 1050 - 1150/1200) are similarly distributed, and fairly often occur on

the same site. The quantity of storage space did not appear to change over time, which McFadden considers evidence for a continuity of subsistence practices. Furthermore, the large quantities of storage space per residence indicate winter occupation, and the close proximity to arable land suggests agricultural surplus was being stored. The Virgin Anasazi also appear to have preferred building several, small well-sealed storage pits rather than relying on jars kept in one large store room, and the use of multiple storage units would have decreased the risk of large-scale loss due to rodent destruction. The change from sandstone, slab-lined cists to the cobble-floored pavements and *jacal*, the name for mud plastered over a pole framework (Lister and Lister 1994), masonry, and composite wall storage rooms may have been an adaptive strategy, enabling the builders to use local materials rather than quarrying and transporting sandstone slabs. Two other commonalities occur: 1) the seemingly regular episodes of construction with intervening periods of abandonment, sometimes occurring over hundreds of years, and 2) pit houses were not rebuilt, but storage units were. The latter circumstance may have been due to the cultural understanding that pit houses were suitable for the burial of community members, while storage units were not. McFadden (1996) considers the cyclical use, abandonment, and reuse of sites to have been adaptive in nature rather than random occurrences, and the abandonment periods to be associated with episodes of environmental degradation. Reoccupation over relatively short term periods could have been due to the transfer of ancestral lands from one generation to the next as part of a tenuring system based on descent. In the context of these observations, McFadden concludes that there is a "Virgin pattern," in which the Virgin Anasazi maintained a cultural ideology whereby "homesteads" in two or more agricultural zones belonged to

particular tenured groups and would be utilized based on climate-related variations. According to McFadden (1996), a system such as this would have resulted in the longterm perception of pit houses as mortuary facilities and an organized method of allocating land over long periods of time.

Previous Research in the Mt. Trumbull Area

Extensive work in the immediate Mt. Trumbull area began with Moffitt and Chang (1978) conducting the first systematic sample survey, covering approximately 2,100 of 9,000 acres. Seventy-two prehistoric sites were identified, primarily from the Pueblo I and II (A.D. 700 - 1100) phases, and a few from the Early Pueblo III (A.D. 1100 - 1150) phase. Moffitt and Chang used a chronological classification that is slightly different than the divisions described above, based on categories used in the 1960s (Aikens 1966; Shutler 1961).

Altschul and Fairley (Altschul and Fairley 1989) report a total of 228 prehistoric sites identified in the Mt. Trumbull study area as a result of Moffitt and Chang and other compliance projects conducted for the Bureau of Land Management. Of the sites that could be dated, one was thought to be from the Archaic period (prior to 300 B.C.), 165 from the Formative period (300 B.C. to A.D. 1200), and 13 from the Neo-Archaic (post A.D. 1200).

Other than the analysis of sherds from Mt. Trumbull sites conducted by Allison (2000) as described in the section above, the work being conducted by the Mt. Trumbull field school participants is the only known laboratory activity on materials from the area.

The six sites near Mt. Trumbull that are the subject of this thesis range in size from approximately 1,000 to 25,000 square meters. The smallest site has no surface structures but does have surface depressions that may indicate pit structures, and the others have rooms that are frequently contiguous and arc around a central area or plaza. Carbon dating indicates the sites range in age from A.D. 640 to 1280, and ceramic data suggest the sites encompass the Pecos Classification periods of Basketmaker III through Pueblo III.

An Excavated Virgin Anasazi Site - The Pinenut Site

The nearest excavated Virgin Anasazi site to Mt. Trumbull is the Pinenut Site (see Figure 1), located approximately 27 miles east-northeast of the center of the Mt. Trumbull project area at an elevation of 5440 ft. The results of this excavation (Westfall 1987) may be used as a likely example of the types of pit houses, room architecture, and other characteristics that would be encountered at Mt. Trumbull were the sites to be excavated (Figure 3).

The Pinenut site appeared to have at least two episodes of occupation. The initial architecture at the site consisted of a pit structure (most likely a domicile), one of the slab-lined cists found on the west side of the site, and a block of two rectangular, stone rooms (Rooms A & B), which were estimated to have been built and in use between A.D. 1050 to 1100 by a small-sized group, such as a single family. A second phase of occupation appears to have occurred between approximately A.D. 1200 to 1250/1275, by which time the pit structure and Room B had been abandoned. During the second phase, Room A continued to be used, and Rooms C, E, and possibly F were built. Room E



Figure 3. Layout of the Pinenut site, an example of Virgin Anasazi architecture at a small site, located approximately 27 miles east-northeast of the center of the Mt. Trumbull project area. Adapted from Westfall 1987.

apparently became the domicile, and Room C may have been used for storage. Room F had a carbon-rich fill, perhaps indicating use as a heating pit. Room D was thought to have been added later during the second phase of occupation, particularly due to the presence of a later ceramic type. The dates of the remaining cists to the east of the rooms are unknown, but ceramics indicate some use during a later occupation.

The circular pit structure (Feature 2) measured 3.3 x 3.7 m, and had been dug into the ground approximately 1 m. Limestone blocks had been laid into a low masonry wall on the rim of the pit. Burned juniper posts and beams indicate a roof that was likely flat and supported by four posts, the remains of which were found upright and evenly distributed around the edges of the pit. A hard limestone bedrock floor had been coated with two different clay plasters. Features found in the floor were a slab-lined, central fire hearth,

two holes thought to be locations where ladder posts may have been inserted, a depression that may have supported a pottery vessel, a large, slightly bell-shaped pit measuring 40 cm long, 32 cm wide, and 17 cm deep that had been covered by a sandstone slab, and a small, bioturbated pit of unknown function. The structure also included a ventilation shaft in the eastern wall, a shaped slab of limestone in front of the ventilator serving as a draft deflector, and a slab-lined niche built into the wall near the ventilator. The pit structure at the Pinenut Site differs from many others in the Virgin Anasazi area primarily in the lack of an interior bench, although benches were less common during the Pueblo I period (Dalley and McFadden 1985). The structure appeared to have been cleaned out prior to abandonment. Only a few artifacts were found on the floor, and those found above the floor are believed to have been deposited as trash during later occupations. The ceramics had a temporal span ranging from about A.D. 525 to 1225. The 494 lithic tools included projectile points, bifaces, notched tools, scrapers, denticulates, other modified flakes, utilized flakes, cores, hammerstones, digging implements, and one each of a drill, a two-handed mano, and a grinding slab, as well as a large percentage of debitage. Both pieces of grinding equipment were found on or near the floor. A burned piece of wood recovered from the floor immediately south of the hearth returned a radiocarbon date of A.D. 1090±60. Pollen and flotation samples indicated the presence of sagebrush, cholla, buffaloberry, nightshade, cattail, corn, goosefoot, pinyon pine, hedgehog cactus, and groundcherry. Based on the flora recovered from the pit structure, the researchers concluded that these earlier occupants had practiced a mixed subsistence system of agriculture and hunting/gathering, and had collected from a larger resource area than occupants of the later features.

Feature 1 is the group of contiguous rooms labeled A through F (Figure 3). While this group of contiguous rooms at the Pinenut Site is laid out in a linear pattern, many, but not all Virgin Anasazi sites have rooms built into an arc shape (Dalley and McFadden 1988).

The closest of the stone rooms to the pit structure, Room A, had attributes indicating it was perhaps used as a ramada. Room B was constructed by digging out a rectangular pit about 12 cm deep and lining its interior with large and blocky limestone slabs, leaving a gap in the center of the east wall for an entry. The pit had been filled with a 10 to 18 cm thick clay deposit, and horizontal limestone slabs were laid into the floor, particularly near where the floor met the walls. The interior of the room lacked any features. Room C was built using a similar construction method to Room B, and also had no interior features, although it is thought to have been built during a later occupation.

The construction of the floor in Room D, believed to have been built late in the occupation, was markedly different than that of the previous rooms. The dug out pit had been inlaid with carefully placed stones and clay, and this surface was covered with fitted flat slabs and a coat of clay 3 - 5 cm thick. The lower walls of the pit were partially-dressed limestone slabs fitted vertically next to each other, and the roof was thought to have been constructed of poles and clay plastered over with mud. There was no entrance to the room. Room E was built generally in an oval shape on the bedrock surface and measured 4 x 3.25 m, with an average depth of 0.4 m. Clay had been spread on the interior to even the floor surface. A gap in the east wall suggested an entryway, and a midden was found immediately outside the entry with a high frequency of broken tools and ceramic sherds. The roof was possibly built with wood beams set across the tops of

the walls, as there were no post holes to suggest a roof supported by interior posts. A slab-lined hearth was the only feature encountered. Room F, the northern-most room in Feature 1, was a small circular structure built adjacent to Room E and may have been used as a type of storage cyst.

All of the rooms in Feature 1 contained pollen from corn. Evidence of other economic species showed the presence of cattail, sunflower, goosefoot, pigweed, mustard, parsley, knotwood, and beeweed. Ceramic sherds and lithics were also recovered from each room. The ceramic styles were similar to those found in the pit structure. Lithics included primarily debitage, plus small numbers of projectile points, bifaces, scrapers, drills, denticulates, other edge-modified flakes, utilized flakes, cores, hammerstones, pecking stones, digging implements, one and two-handed manos, grinding slabs, and abrading stones.

Feature 3, a small complex of circular, stone and slab-lined cists, is located eight meters east of Feature 1. Ceramic sherds similar to types found elsewhere at the site were encountered in the fill of Feature 3, but were recovered from the upper layers and could not be used to temporally place the use of the cists. No pollen from economic plant species were found in the two cists on the western side of the feature, but a small amount of corn pollen was identified in the eastern cist. Of the 106 lithics from Feature 3, most were pieces of debitage, plus small numbers of utilized flakes, bifaces, hammerstones, and other edge-modified flakes, as well as one each of a projectile point, a drill, and a scraper.

Virgin Anasazi Trade and Interaction Patterns

Artifacts are frequently found at sites that were made from materials known to have been transported long distances. These products were likely procured by various means, such as complex economic exchange networks, exchange with relatives who lived in areas near where desired objects were made or procured, other kinship-related trades, or bartering with individual traders. Some other possibilities include bride price or other gift giving, migration, or direct procurement (Sahlins 1972, c.f. Bayman and Shackley 1999). As it is impossible to know the exact means through which an individual item was acquired, the terms trade and exchange are most frequently used in this thesis, with the understanding that other means of acquisition may have been involved.

Virgin Anasazi trade patterns with other groups have been largely identified through the examination of pottery, shell, and turquoise (Allison 2000; Lyneis 1988, 1992; Rafferty 1990; Shutler 1961). Much of the discussion related to Virgin trade is based upon work that has been conducted at Lost City, also referred to as Pueblo Grande de Nevada, located in the vicinity of Overton, Nevada, which was first studied by Harrington in the 1920s and 30s prior to its partial inundation by Lake Mead upon the completion of Hoover Dam. Shutler (1961) later created a compilation of Harrington's work which provides the most comprehensive description of the data.

Some resources, such as salt and turquoise, were mined at Lost City and became part of the regional trade network. Harrington identified three caves and an open pit where salt was mined by indigenous groups within approximately 20 mi of Lost City. Hundreds of stone hammerheads were found in the mines, some with wooden handles still intact, along with roughly chipped picks and choppers. There were also numerous artifacts

related to clothing, eating, and bags for carrying materials, which were similar to those found at Lost City. A few sherds of pottery were found, from ceramic types Virgin Black-on-white, Moapa Black-on-gray, North Creek Fugitive Red, and Pyramid Gray (Harrington 1927; Shutler 1961). A reanalysis of materials from these salt mines has shown that it was used by both Puebloan and Southern Paiute groups. In addition, a chemically sourced sample of salt from an archaeological site in Arizona was found to have originated in this area (Jensen and Slaughter 2009).

The Sullivan Turquoise Mine near Boulder City, Nevada, located roughly 35 mi southwest of Lost City, was worked by the Virgin Anasazi. Although the material was of poor quality, hundreds of artifacts were recovered by a crew from the Civilian Conservation Corps in 1936 under Harrington's supervision. The primary mining tools appeared to be crude pounding and chopping implements. Numerous fire hearths were found near the mine, presumably to heat and crack rock from which the turquoise could be further extracted. Unspecified "Pueblo" pottery was recorded at the mine, providing the best evidence that the Anasazi were the miners. Virgin Anasazi artifacts have also been identified at two other turquoise mines, indicating some level of involvement with the extraction or trade of the materials found there: Halloran Springs near Baker in southeastern California and Crescent Peak on the California-Nevada border west of Searchlight. At Halloran Springs, Lino Gray Ware and one sherd of Moapa Gray Ware were recovered by Malcolm Rogers in the 1920s (Leonard and Drover 1980), and unspecified artifacts were discovered at Crescent Peak (cf. Rafferty 1990). Finished turquoise ornaments from several sources (indicated by the differences in color and texture) were also identified at the Main Ridge site at Lost City (Lyneis 1992).

According to Shutler, salt and turquoise were traded to others in the Virgin region to the north, to the Kayenta, the Patayan across the Colorado river, and perhaps as far as Chaco Canyon to the east, to the Lower Colorado River Patayan to the south, and as far as Death Valley, California to the west (Rafferty 1990; Shutler 1961).

Shell from the southern California coast and the Gulf of California was found in Lost City rooms and burials, which had been manufactured into beads (olivella) and into a pendent (abalone) prior to their arrival at the site (Harrington 1927; Shutler 1961). The western periphery of the Virgin Anasazi area is considered to be on the eastern edge of the shell bead and ornament trade system that occurred between California and the western Great Basin (Bennyhoff and Hughes 1987).

Woven cotton cloth was occasionally recovered from Lost City burials. Although cotton textiles have been recovered from the Virgin Anasazi lowlands, the only evidence that cloth was manufactured in the area comes from Harrington's discovery of several cotton bolls and a small spindle-whorl of unfired clay attached to a broken wooden spindle in a rockshelter not far from Lost City (cf. Lyneis 1992). Cotton appears to have been grown in southern Arizona and traded to northern cultures prior to A.D. 1100. Some cotton seeds have been found at Pueblo sites dated to after A.D. 1100, suggesting that the plant may have eventually been modified to grow in more northern climates (Kent 1983).

Although trade with the Fremont to the north has rarely been addressed in the context of Virgin Anasazi exchange, there is some evidence it occurred. In researching trade patterns among Fremont prehistoric groups, generally located in central and northern Utah, Janetski (2002) noted that small amounts of Virgin Anasazi pottery had been found

at Fremont sites. In a review of sites in the Fremont occupation area, McDonald (McDonald 1994) found 24 of 95 sites to have Virgin or Moapa Series ceramics. These sherds were found in the areas closest to the Virgin Anasazi region. Although researchers had previously interpreted the presence of these Virgin Anasazi ceramics to be indicators that the Virgin Anasazi had themselves inhabited the sites, McDonald states "It is likely that the Fremont and Anasazi of these areas interacted on at least a limited basis." In addition, Fremont pottery was found at the Kayenta Anasazi site of Coombs, in Boulder, Utah, indicating some interaction between the Anasazi and the Fremont at sometime from approximately A.D. 1075 to 1275 (Lister et al. 1960).

The study of ceramics imported into the Virgin Anasazi area has provided the most prolific data on trade into the region. In the 1980s Lyneis returned to Lost City and conducted further work on a segment of the site referred to as Main Ridge (1992). Her work marks the beginning of detailed ceramic analysis for the purpose of determining contact or trade patterns within the Virgin Anasazi region itself (Lyneis 1988, 1992). Several types of pottery found at Main Ridge were determined to be non-local in origin. Tsegi Orange Ware, San Juan Red Ware, and Black Mesa Black-on-white denote interaction with Kayenta-linked groups east of Kanab Creek (Lyneis 1996). Virgin Black-on-white is believed to be a product of the Kanab area. Shivwits Plain Ware is from the Shivwits Plateau, which makes up a large portion of the western half of the Arizona Strip, and Moapa Gray Ware (so named due to the belief that it originated in Moapa Valley) is primarily from the Mt. Trumbull area on the Uinkaret Plateau in the central portion of the Arizona Strip. Lyneis (1992) also discovered that Tusayan Wares, Virgin Series, having mixed sand tempers were made with sands found in the Virgin

River drainage. Some Tusayan Wares were recovered from at least one site at Mt. Trumbull.

Allison (2000) continued the discussion on ceramic exchange through the Virgin Anasazi region, noting that the heaviest importation of ceramics into Moapa Valley from the east began approximately A.D. 1050 and ended around A.D. 1125 to 1150. He postulated that ceramic exchange between the upland inhabitants of areas such as Mt. Trumbull and the valley groups likely occurred due to a combination of risk-buffering and, primarily, mutualism. With regard to risk-buffering, maintaining trade partnerships with each other ensured that relationships existed in case of subsistence failure. Mutualism refers here to trade that is mutually beneficial to both of the involved groups. Allison suggests that upland groups were better able to make pottery, particularly because of an abundance of wood for firing, which was not available to valley populations, in which case, lowland groups could exchange a resource that was relatively inexpensive for them to access, such as food surplus, for pottery (Allison 2000). Per Lyneis (1996), the internal Virgin Anasazi exchange system between the upland regions and the lowland areas to the west was non-centralized and a "deeply embedded" part of the economy.

Although Aikens was not focusing on trade patterns, his comparison of excavated archaeological sites between the Kayenta and Virgin Anasazi regions (1966) did reveal information on interaction between the two groups. Prior to about A.D. 900, Aikens noted an almost identical pattern of formal and functional attributes between the two groups, particularly in the areas of architecture, tools, items of clothing, and ceremonial objects, suggesting they were "participants in a uniform cultural pattern and sociological interaction sphere which had newly extended itself over the whole of the northern

Southwest, including the Mesa Verde, Chaco, Little Colorado, Kayenta, and Virgin areas." After that time, there remained many similarities, suggesting a high degree of continued interaction, but they also became "separate sociocultural populations." The primary differences were in architecture and in some subsistence technology. The arc-shaped line of room blocks became common in the Virgin area, but in the Kayenta region lines of room blocks were built in a straight or "L" shaped pattern. The mealing bin, essentially a permanent grinding surface with short walls around it and often found inside a room, became common in the Kayenta area, but were rarely found at Virgin sites. As mentioned above, orange and red ware ceramics from the Kayenta region have been found at Virgin Anasazi sites. Aikens remarked on directions of ceramic trade between the two groups, noting that pottery seems to have moved from Kayenta to Virgin areas, rather than the reverse.

With regard to exchange into the Mt. Trumbull area in particular, Perry conducted an analysis of the pottery from site AZ:A:12:14 (ASM) as part of the Mt. Trumbull field school project, which is also one of the sites for which a lithic analysis was completed for this thesis. The locally made Moapa Gray Ware was the type most commonly found at the site, making up 76.7 percent of the assemblage. The remainder of the sherds were from other Virgin Anasazi type ceramics, and a small percentage were from pots imported from the Kayenta Anasazi area (Perry 2004).

Research on the distribution of Moapa Gray Ware, an olivine-tempered pottery, has been particularly helpful to those studying internal Virgin Anasazi trade patterns. Olivine is known to come from a source near Mt. Trumbull (Eva Jensen and Paul Buck, personal communications and visit to source). When pottery with this temper is identified outside

the Mt. Trumbull area, archaeologists have reason to believe that it arrived at its location of discard through the means of interaction with people who likely lived near the olivine source. Lyneis noted olivine nodules are rarely found in the Moapa Valley, and the clays used to produce Moapa Gray were more visually similar to pottery found in the Mt. Trumbull area than those found in Moapa Valley. For these reasons she believed Moapa Gray Ware was primarily produced in the Mt. Trumbull region and carried into the Moapa Valley, rather than raw olivine nodules being transported to the area. Many of the utilitarian ceramics found at Main Ridge were from the Arizona Strip, indicating regular interaction between the two regions (Lyneis 1988, 1992).

More recently, the use of instrumental neutron activation analysis (INAA) and laser ablation inductively coupled plasma mass spectrometry (LA-ICP-MS) on ceramic sherds of olivine-tempered pottery found in both the Mt. Trumbull and lowland Virgin Anasazi areas has shown more variation in the clays used to make Moapa Gray Ware than previously understood. In preliminary analyses, Sakai (2009) has learned that although some of the Moapa Gray Wares found in Moapa Valley were made of clays originating in Mt. Trumbull, others appear to have been made with lowland area clays. This suggests that olivine in its raw form may still have been transported to Moapa Valley even though it is seldom recovered from sites in the area, or perhaps there are sources of olivine closer to the lowland region than those that are currently known. Her work on Virgin Anasazi ceramics continues and will significantly improve our knowledge of pottery made in the region.

Ceramic exchange between the Moapa Valley and the Shivwits and Uinkaret Plateaus appears to have been at its peak from A.D. 1050 to 1100. It has been estimated that over

30 percent of the pottery used in the Moapa Valley during this temporal range came from the plateaus, and some households appeared to import more non-local wares than others. By refiring a sample of Moapa Gray Ware sherds found both at Mt. Trumbull and in the Moapa Valley to identify clay colors, Allison (2000) was able to determine that only pottery made from some of the clays used at Mt. Trumbull were transported to the valley. Although pottery that refired to both light and dark colors was found at Mt. Trumbull, the lighter colored pottery was more often found at sites in the Moapa Valley, indicating that some Mt. Trumbull potters traded their wares more often with valley inhabitants than others. When comparing Moapa Valley sites to each other, 15 of 21 sites had higher proportions of some colors of sherds than others, which suggested to Allison that each Moapa Valley household may have had trade partnerships that were stronger with some producers at Mt. Trumbull than with others, and that these relationships may have continued over more than one generation. Valley residents did make their own local pottery, but different households supplemented their supplies with imports to varying degrees.

Allison's research on the Virgin Anasazi (2000) led him to the development of a model for exchange between the Mt. Trumbull (upland) and Moapa Valley (lowland) regions. The valley's deficiency in firewood made pottery production somewhat more costly for the lowland inhabitants, but their growing season was longer and more reliable than that on the plateaus. Due to differences in elevation and climate, the groups in the two regions also had access to different wild plant and animal resources. Allison's model combined elements of risk-buffering and mutualism, but with a higher emphasis on mutualistic motivations. Under the risk-buffering model, exchange would have been

primarily in the form of gift-giving to create an alliance between the two in case one group should have a shortage of resources. Risk buffering is also seen as advantageous to groups who produce similar resources, such that the same resource that was lacking for one group would be available from the other group when needed, which is not the case between the Moapa Valley and Mt. Trumbull regions. In addition, since risk of unproductive crops was higher in the uplands due to occasional low rain levels or frost, the lowland populations would not have been motivated to trade for the purpose of riskbuffering alone. Thus, there must have also been other beneficial elements to trade relationships between the two. The mutualistic model, which is a better fit for these upland/lowland populations, is more common between groups who have access to diverse resources, and among groups that are more sedentary and do not have the opportunity to travel and collect more distant products. Each group would have traded goods that they could acquire at a low cost, and, in the case of these Virgin Anasazi groups, the types of goods preferred in trade likely differed from household to household. The differential quantities of Mt. Trumbull ceramics in Moapa Valley sites also led Allison to believe that social ties, such as kinship or other relationships, affected exchange practices, and that ceramic trade occurred at social gatherings, such as festivals.

Pottery made near Mt. Trumbull has also been identified in the Las Vegas Valley (Rowe 2002). Olivine-tempered ceramics have been recorded at a small number of sites between Overton and Pahrump, but in lower quantities than those found in Moapa Valley. With regard to transportation routes, the presence of Virgin Anasazi ceramics in the Las Vegas region indicates an overland route of contact that ran northeast from the Las Vegas Valley to Moapa Valley (Ahlstrom and Lyon 2004). This route appears to

have been used more often than a shorter, alternate route with access to better water sources which extended along the Colorado River up to the Virgin River. The exact reasons for use of the longer route are unknown, but it may have been partially due to a potential conflict between groups.

Regional Obsidian Trade and Interaction Patterns

From the time chemical analysis was first used by archaeologists to identify the source of obsidian (Dixon et al. 1968), sourcing has become a common method used to learn about cultural interactions between groups (Baugh and Nelson 1987; Bayman and Shackley 1999; Dixon et al. 1968; Harry 1989; Hatch 1990; Hughes 1994; Jones et al. 2003; Parry 2001; Pires-Ferreira 1978; Torrence and Summerhayes 1997). The only previously published information on obsidian sourcing of materials found in or immediately adjacent to the Arizona Strip comes from Nelson (1984) and Lesko (1989). In Nelson's sample of obsidian found in western North America, eight pieces from the Arizona Strip and just north of the Utah-Arizona border were analyzed. All eight artifacts were from the Modena and Wild Horse Canyon sources. In Lesko's study, of the 32 obsidian samples from archaeological sites within or near the Kaibab National Forest that could be successfully sourced, nine were from Pumice Hole, Wild Horse Canyon, and Modena in Utah, and 23 were from the volcanic area south of the Grand Canyon between Flagstaff and Seligman, AZ. Although this information has been available for some time, it has only been mentioned with regard to our understanding of the Virgin Anasazi in passing (Altschul and Fairley 1989).

The inhabitants of Las Vegas Valley sites having olivine-tempered pottery, which indicates relationships to Mt. Trumbull-area pottery producers (Rowe 2002), were part of a more localized network of interaction with regard to obsidian acquisition. The few obsidian artifacts collected from the Las Vegas Valley sites studied by Rowe were sourced to southern Nevada and southeastern California locations (Martin 2005).

Research on exchange systems in other regions may also shed light on possible obsidian procurement strategies practiced in the Arizona Strip. Distribution may have occurred during large social events which brought many people together. Bayman (1995), in an analysis of obsidian distribution around a Hohokam mound site, has proposed that individuals from small outlier sites acquired obsidian while attended community events put on by the elite who inhabited higher-status homes at the mound and controlled the distribution of goods. Obsidian points were also found in middens near the mounds, and may have been deposited there as part of a ritual activity. Shackley, in a discussion on ball court events (2005), has suggested that perhaps obsidian projectile points with stylistic attributes representing the groups who made them were awarded to winners of contests at these events. Items may have also been procured through theft (Winterhalder 1997), or perhaps an obsidian projectile point was found after it was lost by another hunter (Andrefsky 1998). In essence, the possibilities are numerous; however, we know that exchange was a common occurrence and could very likely be the method by which the Virgin Anasazi near Mt. Trumbull acquired their obsidian tools. While they may have attended events where prestige items were distributed by elites, there are no known large, or even mid-sized, community complexes or event centers in or near the Virgin Anasazi region which could be interpreted as elite-

controlled areas. The Arizona Strip even appears to lack many kivas, which would provide an indication of non-secular leadership. In addition, the identification of any elite individuals or groups within the Virgin Anasazi is difficult because of the few burial contexts in which artifacts have been recovered. The Mt. Trumbull project in particular purposefully avoided areas within sites which would have been likely to contain graves. This is not to imply that the Virgin Anasazi lacked an elite hierarchy, but rather the types of archaeological evidence that is normally used to identify the elite in other Southwestern contexts is not readily available for Virgin Anasazi researchers. For the purposes of this analysis, the acquisition of obsidian will be discussed primarily in the context of contact between groups, acknowledging that the obsidian found near Mt. Trumbull could have arrived there by a variety of means, including trade/exchange, direct procurement, mobility, gift-giving, and others.

Adjacent Regional Obsidian Procurement Models

In order to interpret the findings of the obsidian sourcing of artifacts at Mt. Trumbull, it is helpful to understand the procurement systems that have been identified in nearby regions. This section provides descriptions of what archaeologists have learned through obsidian sourcing in the Southwest, the eastern Great Basin, and central Utah.

The Southwest

The closest Southwest obsidian source region to Mt. Trumbull is in northern Arizona. The Mount Floyd and San Francisco volcanic fields are located in Coconino County, Arizona, which is immediately south of the Grand Canyon. Mount Floyd includes the Partridge Creek (Round Mountain) source, and the San Francisco Field encompasses

Government Mountain. These northern Arizona sources were traded as part of the Classic-period (AD 1150 to 1450) Hohokam exchange system. San Francisco and Mount Floyd obsidian artifacts found at Hohokam sites near and south of modern-day Phoenix, Arizona are thought to be indicators of a well-developed trade network between the Hohokam and the Anasazi and Sinagua. A higher than expected amount of obsidian at these sites that originated from Government Mountain, which is between 210 and 275 miles north of the sites used in the study, is believed to have been acquired for social or cultural reasons, and was perhaps traded for cotton or shell (Mitchell and Shackley 1995). Most of the formal tools found at El Polvorón were made from San Francisco field obsidian, which is located 150 km to the north. Peterson et al. (1997) suggest that these tools may have arrived at the Hohokam site in finished form. The presence of San Francisco field obsidian at large Hohokam community sites rather than platform mound sites, leads Peterson et al. to hint that obsidian from greater distances was available to members of the community in general rather than being part of a restricted elite exchange system.

The Eastern Great Basin

A study which included obsidian artifacts collected from post-6,000 B.P. sites in the eastern Great Basin area (Haarklau et al. 2005) found that 41 percent of the material came from the Panaca Summit-Modena region. Obsidian from this source appeared to be transported exclusively to the northeast, east, and southeast. Wildhorse Canyon obsidian was the second most common obsidian found in the sample, with 24 percent. Stevenson (2008) conducted chemical sourcing research on artifacts from sites in Washington County, Utah, which is considered to be the northern extent of the Virgin Anasazi region

and on the edge of the eastern Great Basin. He identified the Modena source as the most common type of obsidian of which artifacts were made at formative sites in his study area. Almost 80 percent of the obsidian analyzed from this time period was from Modena.

Central Utah

Janetski looked at obsidian sourcing results for Fremont sites in central Utah and found differing patterns in procurement between sites on the Colorado Plateau versus in the eastern Great Basin. Colorado Plateau sites usually contained very low percentages of obsidian. While this would at first seem to be simply a result of distance from potential sources, it was also found that some sites in the eastern Great Basin, where obsidian sources are closer, also had low percentages of obsidian, although not as low as most plateau sites. In addition, obsidian found at some Fremont sites had been acquired from the nearest sources, and in other cases it had not, implying a different method of access for Fremont groups in certain areas compared to others (Janetski 2002; McDonald 1994). McDonald suggested that the different methods of access could be related to the decrease in mobility during the Fremont period, which would have increased the motivation to acquire obsidian through exchange rather than directly traveling to the source.

CHAPTER 4

FLAKED STONE ANALYSIS - METHODS AND RESULTS

This chapter presents the methods used for the flaked stone analysis and the results for each separate site assemblage. For each site there is a brief description of the architectural features and other non-flaked lithic artifacts, followed by detailed analysis results organized in the order of bifaces, cores, edge-modified flakes, debitage, use wear, and raw material types. At the end of the results for each site, I present an individual interpretative summary of the behaviors that may be inferred from that particular assemblage.

Methods

Flaked lithic materials were collected during field schools at six sites within the project area. The goal was to sample 150 pieces from each of the surface and subsurface assemblages from each site. For four sites the goal was not reached, in which cases all of the items from the assemblage make up the sample. Where a surface or subsurface assemblage had more than 150 pieces, all of the pieces in the last bag were counted to avoid a bias of selecting certain types of artifacts over others (i.e., tending to pick up larger or glossier items). Thus, if the 150th piece was reached while analyzing a bag of 40 pieces, all of the pieces were included in the sample, which resulted in a sample size for that assemblage of over 150 pieces. Surface assemblages were analyzed in surface collection unit (SCU) number order, and subsurface materials in test pit (TP) number order, until the 150 sample number was reached. Table 1 shows collection information and the number of artifacts analyzed for each site and assemblage type. Characteristics

of the six sites are presented in Table 2. All of these artifacts, including the obsidian, were analyzed first without magnification, followed by use of a 10x hand lens when necessary. The data attributes recorded are listed and defined in Table 3.

Table 1. Characteristics of each site collection and the number of artifacts analyzed from each surface collection unit (SCU) and test pit (TP) from each assemblage.

			Total	Assemblage Type		
Site	*SCU	Test	Count of			Total Count of
	area	Pits	Lithics	SCU	TP	Analyzed Artifacts
			Collected			
AZ:A:12:136 (ASM)	240	3	65	193	203	396
AZ:A:12:14 (MNA)	250 + 3	4	153	241	180	430
	rooms	4	155	241	109	430
AZ:A:12:204 (BLM)	200	5	691	33	32	65
AZ:A:12:214 (ASM)	348	3	619	123	58	181
AZ:A:12:30 (BLM)	260	5	181	151	163	314
AZ:A:12:71 (ASM)	392	15	>1946	112	43	155
Total Analyzed Artifacts				853	688	1541

* Estimated square meters subject to surface collection.

Raw Material Type

Material type was based on groupings such as chert, obsidian, basalt, and quartzite, in conjunction with a texture classification. Three geologists (Dr. Clay Crow, UNLV; Dave Corry, BLM in St. George, Utah; George Billingsley, lead author for the USGS geological map for the Mt. Trumbull area) were shown a sample of the non-obsidian flaked stone artifacts from the Mt. Trumbull assemblage. They each used different nomenclature for most of the stone types. In addition to this complication, Luedtke (1992) has noted that there are no inherent categories of chert. This lack of consensus on the part of geologists regarding the naming of lithic materials used at Mt. Trumbull and the known difficulties of typing chert materials made it necessary to develop a material type attribute that was based on the texture of the stone in order to assess material quality.

Sito	Cultural Period	# Rooms	** ¹⁴ C	Point	Diagnostic Pottery Data	
Sile			(A.D.)	Dates (A.D.)	% Corr	# Painted
AZ:A:12:214 (ASM)	PII - PIII	7	640-770	600-1300	18%	[†] At least 4
AZ:A:12:204 (BLM)	BMIII - PI	5 pithouse depressions	810-890	*500-1300	0%	0
AZ:A:12:71 (ASM)	BMIII +	11	880-1010	950-1150	6%	0
AZ:A:12:14 (MNA)	PII	20	880-1010 1000-1170 1020-1210 1160-1280	500-1300	35%	144
AZ:A:12:30 (BLM)	PII - PIII	20	960-1040 1110-1190	500-1300	9%	[†] >170
AZ:A:12:136 (ASM)	PII - PIII	15	1000-1030	*500-1300	10%	[†] At least 1 polychrome

Table 2. Summary of sites included in this analysis ordered by earliest ¹⁴C date.

** ¹⁴C dates are from augered samples and may not be from cultural contexts, with the exception of the A.D. 1110-1190 date at AZ:A:12:30(BLM), which came from a corn kernal.

* Single large projectile points at these sites may indicate an earlier occupation or may have been carried into the sites from elsewhere.

[†] Ceramic analyses on these sites have not been completed, and the exact number of painted sherds is unknown.

Material Texture

The texture groups were determined subjectively by arranging artifacts from each bag in order of increasing coarseness, and then by assigning values based on a 5-point scale, where 1 was finest (used for obsidian) and 5 was coursest (used for basalt and gritty chert). If an artifact consisted of two or more different textures, the texture making up the highest percentage of the piece was recorded. George Billingsley believes almost all of the non-obsidian stone to be chert and locally available (personal communication). For this reason, all artifacts that were not clearly obsidian, basalt, or quartzite, were

		Research			
A 11		question			
Attribute	Description	to be			
		addressed			
Unit Number	Surface Collection Unit or Test Pit identifier				
	S = surface				
	Level $1 = 0-10 \text{ cm}$				
	Level $2 = 10-20$ cm				
Danth	Level $3 = 20-30$ cm				
Depth	Level $4 = 30-40$ cm				
	Level $5 = 40-50 \text{ cm}$				
	Level $6 = 50-60 \text{ cm}$				
	Level $7 = 60-70$ cm.				
Material type	Obsidian, chert, red petrified wood, basalt, quartzite, quartz	2, 4			
Material texture	A 5-point scale ($1 = most$ fine grained; $5 = coursest$)	2			
	1 = >100 mm $7 = 25-30 mm$				
	2 = 80-100 mm $8 = 20-25 mm$				
Size code	3 = 60-80 mm $9 = 15-20 mm$	1 2 4			
Size code	4 = 50-60 mm $10 = 10-15 mm$	1, 2, 4			
	5 = 40-50 mm $11 = 5-10 mm$				
	6 = 30-40 mm $12 = <5 mm$				
	Complete = includes platform, termination, and both side				
	edges.				
	Proximal = includes platform and bulb of percussion.				
	Distal = includes flake termination.				
	Lateral = includes side edge, but not proximal or distal				
Portion of flake	portions.	2			
I OITIOII OI IIAKE	Medial = includes side edges, but neither proximal nor	2			
	distal portions.				
	Central = includes some of proximal and distal ends, but				
	missing both edges.				
	Split = includes part of proximal and distal edges and				
	one side.				
Number of dorsal	Number of facets on dorsal surface of flake, each of which				
flake scars	indicates the previous removal of a flake by means of	1			
	conchoidal fracture.				
Presence/absence	Attributes are angular, blocky, fragmented, and lacking				
of shatter	flake attributes (see Appendix A for flake attribute	1			
attributes	definitions).				
Number of side	Number of locations (functional units) on flake margins				
margins with edge	where flakes have been removed to create a particular angle	1, 2			
modification	and sharpness of edge.				
Number of side	e Number of locations (functional units) on flake margins				
margins with where damage has occurred that may be the result of using					
possible usewear	possible usewear the edge as a tool.				
Amount of cortex	(<25% or >25%) Cortex is the chemically or mechanically	lly 1			
	weathered surface of a stone.	I			

Table 3. List and definitions of lithic attributes recorded, and which research questions the attribute addresses.

		Research
A 11		question
Attribute	Description	to be
		addressed
	Simple = Unprepared striking location on a core with a single facet.	
Type of platform	Complex = Prepared striking location on a core, having multiple facets created to increase control over the how the material fractures. Cortex = Strike made on weathered surface of material	1, 2
Presence/absence of grinding at platform edges	Grinding is abrasion applied to a striking platform to increase control over how the material fractures.	1, 2
Presence/absence of a lip on the ventral side of the platform	The lip on a newly created flake is a small portion of the core that is removed with, and extends beyond, the platform of the new flake toward the ventral surface, in the opposite direction of the applied force, usually during soft hammer percussion.	1
Complete flake's maximum length, width, thickness, and weight	Measurements are made in centimeters and weight is taken in grams.	1, 2
Tool type code	BIF=biface BUR=burin COR=core DRL=drill EMF=edge-modified flake EMS=edge-modified shatter PJP=projectile point (Projectile type classifications were based on Justice (2001) and Wells (1991).) SCR=scraper UNI=unifaces UTF=utilized flake UTC=utilized core UTS=utilized shatter	1, 2, 4
Size-to-dorsal-	Maximum dimension in centimeters divided by number of	1
scar-count ratio	dorsal flake scars.	1
Weight to dorsal	Weight in grams divided by number of dorsal flake scars.	1
scar count ratio		
Obsidian sourcing	Results of XRF analysis indicating source of raw obsidian	3

Table 3. List and definitions of lithic attributes recorded, and which research questions the attribute addresses - continued.

categorized as chert. George Billingsley identified a red, fine-grained chert as petrified wood (see Figure 4, Category 2 for an example). This material is present in northern

Arizona due to the burial of trees by large amounts of sediment, which cut off oxygen and slowed decay. Over hundreds and thousands of years, minerals that had absorbed into the wood became crystallized, and replaced the organic material. About 60 million years ago, uplifting and dissecting in the Colorado Plateau caused some of these petrified materials to reach the surface (cf. Luedtke 1992; National Park Service - USDI 2007). Figure 4 shows an example of each texture category.





Good quality cherts are readily accessible in the Mt. Trumbull area, with large cobbles of Category 2 and 3 textured materials eroding out of cliffs approximately 13 miles to the east. Category 4 and 5 materials are also readily available according to USGS geologist George Billingsley, but their exact source locations have not been identified as part of this project. The 13-mile distance is well within the area that other researchers have defined as local. For example, Leonard et al. (1989) defined local materials as those which would have been accessible within a few hours' walk, or less than 15 km (9.3 mi).

Flake Portion

In an effort to determine if toolstone type may have affected flake portion in the Mt. Trumbull assemblage, percentages of broken flakes for each texture category were calculated. However, this calculation proved problematic, as a number of variables could result in broken flakes. Excluding flakes that had been used as tools in order to eliminate the possibility that these flakes had broken as a result of use would not take into account the effect of toolstone preference on the part of the tool maker or the effect of toolstone mechanics. If flakes of one texture category were selected to use as tools more often than another texture, or one texture category broke more easily than another during tool use, the remaining population of flakes being employed for the calculation would be skewed. In addition to these issues, many previous experiments carried out to learn about flake portion were conducted on bifacial cores, which were non-existent in the Mt. Trumbull assemblage. Thus the results of experiments on bifacial cores would not be applicable to the samples collected for this project. Due to the problems of relating flake portion to behavior, the attribute was not considered as a line of evidence with regard to reduction stage.

Where measurements were taken on flakes to establish assemblage characteristics, complete flakes were used. In addition to the use of complete flakes compared against the smallest tools mentioned above, complete flakes were also used to determine whether the flakes at a site tended to be large on the average. Proximal flake portions were included in calculations related to platform characteristics.

Dorsal Scar Count

Dorsal scar count is believed to be helpful for interpreting production activity; however, using a straight count of scars may be problematic (see discussion in Chapter 2), and finding a useful model to apply to the Mt. Trumbull assemblage proved difficult. Shott has noted that scar count needs to be corrected for size (Shott 1994), but did not discuss how that should be accomplished. Bradbury and Carr's percent complete model (1999) was designed to be applicable to biface reduction, rather than core and biface reduction mixed assemblages. Carr and Bradbury (2001) used scar count among other variables to identify later stage flakes, but the use of the equation related to core reduction required an adequate number of small flakes, which is not present in the Mt. Trumbull assemblage. In an effort to create a model in which the dorsal flake scar count could be meaningfully applied to this analysis, two types of ratios were used: size (maximum dimension in centimeters) divided by the number of dorsal flake scars and weight (in grams) divided by dorsal flake scars. A description of the statistical analysis is discussed in detail in the section describing the lithic analysis results for site AZ:A:12:136 (ASM) below, and a brief statement regarding this ratio is provided for each site thereafter.

Use Wear and Retouch

With regard to the identification of informal and formal tools, types of use wear on flakes are very difficult to accurately identify macroscopically (George Odell, personal communication, Andrefsky 1998). There may also be other causes of edge damage due to natural formation processes, such as trampling, they may be confused with use wear (Tringham 1974). McBrearty et al. (1998) noted that a similar problem occurred when identifying retouch on tools. With this in mind, use wear and retouch were only recognized where the damage or retouch pattern was clearly continuous across the functional unit, and no effort was made to categorize types of damage.

Results of Flaked Stone Analysis

The section below presents the analysis results for each site. Behavioral interpretations of the results as they relate to the Mt. Trumbull sites as a whole are discussed in the context of the research questions in Chapter 6.

AZ:A:12:136 (ASM)

Located among a group of four sites in this project that are roughly four miles southeast of Mt. Trumbull, the primary architectural feature at this site is an E-shaped pueblo with approximately 20, mostly-contiguous cists or rooms represented by collapsed rings or squares of basalt boulders (Buck 2005). A previous site form reported a dense artifact concentration, particularly eroding down the southeastern and eastern slopes of the hill, containing thousands of sherds and lithics, including a Rose Spring point. Much of the pottery was Moapa Gray Ware, and a polychrome sherd was also recorded. A site form from 2004 suggested from the artifacts that an occupation during the Pueblo II-III periods was likely. Three shallow depressions may represent pithouses. At least seven other collapsed single architectural rock features and a petroglyph are located within 50 m of the E structure, and a possible midden is located on the southeast side. The site encompasses approximately 24,000 m². During the current project, three possible hearths were identified during testing, and two hammer stones were recovered from one of the

test pits. A shovel test placed in a small damaged structure east of the pueblo encountered a few large Shivwits corrugated jar sherds above an irregular, compact clay layer. A large charcoal piece found immediately below the sherds returned an AMS radiocarbon date of A.D. 960-1040 (Buck 2005). Another carbon 14 sample recovered by augering had a result of A.D. 1000 to 1030 (Buck and Sakai 2006). A total of 8.7 percent (534 sherds) of the pottery recovered from the site was corrugated. Painted pottery was also present, but the percentage was not available, as the assemblage had yet to be analyzed. Over 690 lithics were collected from 240 square meters of surface units and five test pits.

The required number of surface and subsurface artifacts to reach the sample size for this site was achieved with Surface Collection Units (SCUs) A2-A5, A7, A9-A12, B1, B4 and Test Pits 1 and 2. SCUs A1, A6, A8, B2, and B3 did not contain any lithic materials. Of a total of 396 lithic items, 193 (48.7 percent) were collected from the SCUs. From the test pits, 19 artifacts (4.8 percent) were from the surface, 33 (8.4 percent) were from 0-10 cm, 62 (15.6 percent) from 10-20 cm, 31 (7.8 percent) from 20-30 cm, 30 (7.6 percent) from 30-40 cm, 26 (6.6 percent) from 40-50 cm, and one (0.5 percent) from 60-70 cm. The assemblage included five bifaces, nine edge-modified flakes (of which four had points that could have been used as burins), six cores, eight projectile points, three scrapers, two unifaces, as well as 41 utilized flakes and pieces of shatter.

Bifaces

Eight projectile points were recorded in the sample assemblage (Table 4, Figure 5). The point from SCU B4 was a Rose Spring contracting stem point (designated "A") of a rust-colored, medium-grade (Category 3) material, lacking the extreme tip. The other

surface point, from Test Pit 1, and again from Category 3 material, was a complete Rose Spring contracting stem point (designated "B"). The 10-20 cm level of Test Pit 2 produced the proximal end of a white, Category 3 chert, large, side-notched point. A

 Table 4. Measurement and weight data for analyzed projectile points from site

 AZ:A:12:136 (ASM).

Туре	Condition	Provenience	Max Length	Max Width	Max Thickness	Weight (g)
Rose Spring CN (A)	Almost Complete	SCU B4	3.2	1.8	3.5	n/a
Rose Spring CN (B)	Complete	TP1, Surface	2.5	1.2	0.4	1.03
Side-notched Point	Incomplete	TP2, Level 2	n/a	1.9	0.4	n/a
Corner-notched ES	Complete	TP2, Level 3	2.0	1.1	0.2	0.6
Parowan Point (A)	Almost Complete	TP2, Level 3	2.4	1.3	0.3	0.82
Eastgate	Incomplete	TP2, Level 3	n/a	n/a	0.3	n/a
Parowan Point (B)	Incomplete	TP2, Level 3	n/a	1.8	0.4	n/a
Corner-notched CS	Incomplete	TP2, Level 7	n/a	1.5	0.4	n/a

CN=corner-notched; CS=contracting stem; ES=expanding stem; SCU=surface collection unit; TP=test pit; n/a=not available.



Figure 5. Projectile points from the site AZ:A:12:136 (ASM) sample assemblage.
small, white, corner-notched, expanding stem point of Category 3 chert was collected from the 20-30 cm level of Test Pit 2. Another point from the same level, a rose-colored Parowan point (A) of Category 3 chert, was basal-notched and lacked the extreme proximal and distal ends. A fine-grained (Category 2) red chert, Eastgate point from the same level lacked three of its sides. The fourth point from the 20-30 cm level of Test Pit 2 was a white, Parowan, Category 3 chert point (B) lacking its tip. The point from the 60-70 cm level of Test Pit 2 was a Category 3, chalcedony corner-notched, contracting stem point. Rose Spring points are estimated to have appeared around A.D. 500-700 and terminated A.D. 1300. Eastgates have a similar chronology, perhaps appearing about A.D. 600. Parowan points are thought to be later, appearing near A.D. 950 and ending approximately A.D. 1150. Large side-notched points of similar size and shape to the one recovered from Level 2 of Test Pit 2, probably used as darts thrown with an atlatl, have dates estimated to before 1500 B.C. in California and prior to 3000 B.C. in the Great Basin (Justice 2001), although there is no other indication the site was occupied at such an early date. Projectile points made up 2 percent of the lithic sample. (The percentage referred to here and at the end of each tool type discussion refers to that of the entire site sample.)

Four other biface fragments and one complete biface were recorded in the analysis. Two were made of a fine chert and the other three of the Category 3, medium-grade chert. Three bifaces were recovered from surface units, one was found in the 0-10 cm level of Test Pit 2, and the fifth was from the 10-20 cm level of the same pit. Two of the biface fragments were too small to determine a stage. One of the larger mid-stage biface fragments found on the surface bore an edge pattern that may be denticulated. The

complete biface, also mid-stage, was recovered from the 10-20 cm level of Test Pit 2. The extreme tip was missing and the proximal end was broken and reworked. It measured 2.9 cm in length, 1.7 cm wide, 0.4 cm thick, and weighed 1.91 g. The fifth biface may be the extreme distal end of a point. These five bifaces made up 1 percent of the assemblage sample.

Cores

Six chert cores (four multidirectional, one unidirectional, and one assayed cobble) were recorded in the assemblage sample (Table 5). Particularly of note, was an unusual red, Category 3 chert core fragment from the 10-20 cm level of Test Pit 2, which appeared to be unidirectional (Figure 6). Most cores at Mt. Trumbull are multidirectional, and the direction of the scars seems somewhat random. The red chert core appears to have all six negative flake scars running in the same direction. The other

		Texture			#Neg			Weight	
Unit ¹	Depth ²	Category	Type ³	Prep ⁴	Scars ⁵	#Plat ⁶	MaxDim ⁷	(g)	Por ⁸
SCUA3	S	4	AC	UN	1	1	3.1	6.78	COM
SCUA5	S	4	MUL	IND	4	IND	4.9	20.11	IND
SCUB4	S	3	MUL	UN	16	5	3.8	35.23	COM
TP1	L2	4	MUL	UN	11	5	6.9	84.68	COM
TP1	L2	3	MUL	UN	5	2	3.1	11.12	FRAG
TP2	L2	3	UNI	IND	6	IND	3.4	11.17	FRAG

Table 5. Attributes of cores recovered from 136 (ASM) in order of unit and depth.

¹ SCU=surface collection unit; TP=test pit.

² S=surface; L=level.

 3 AC = assayed cobble; MUL=multidirectional; UNI=unidirectional.

⁴ Prep=preparation type; IND=indeterminate; UN=unprepared.

⁵ Number of recognizable negative flake scars.

⁶ Number of recognizable platforms.

⁷ Maximum dimension (cm).

⁸ Portion: COM=complete; FRAG=fragment; IND=indeterminate.



Figure 6. Core from Test Pit 2 and example of a typical core found in the area.

unidirectional core coded in the analysis had only one negative flake scar. A small quartzite cobble with one flake scar was found in SCU A3; however, the scar may have not been the result of intentional flake production. The chert cores made up 1.5 percent of the total Mt. Trumbull sample assemblage.

Edge-modified Tools

Fourteen edge-modified tools were recorded in the sample (Table 6), one of which was complete. Three of these had an edge that was sufficiently angled to classify the tool as a scraper. The steepest angles on these tools were 85 degrees on one, and approximately 80 degrees on the other two. Nine of these tools also had patterns elsewhere on one or two edges that may have been the result of use. Pointed tools on four items may have been used as burins. All of the tools classified as burins also had edge modification and/or use wear damage. One flake was crushed on an edge opposite from the modification, perhaps to prevent a sharp edge from cutting the palm during use. The only complete tool, a burin from Level 3, measured 2 cm in length, 2.5 cm wide, 0.5 cm thick, and weighed 2.19 g. The tool fragments ranged in size from 5 to 80 mm, with half falling into the range between 25 to 40 mm. With regard to material type, ten tools

were of medium-grade, Category 3 chert, three were made from Category 4 chert, and one was of the coursest, Category 5 chert. In addition to the tools listed in Table 6, one piece of Category 3 shatter had a pattern along one edge that may have been the result of edge modification. Edge-modified tools made up 3.5 percent of the sample assemblage.

Table 6. Edge-modified tools at site 136 (ASM).

Tool Type	Surface	Level 1	Level 2	Level 3	Level 4	Level 5
Edge-modified flakes	3				1	1
Unifaces	2					
Burins	3			1		
Scrapers	1		2			

Debitage

The assemblage sample included 278 flakes and 98 pieces of shatter. These numbers include flakes and shatter made into, or used as, tools but still retaining recognizable flake or shatter properties. Of the flakes, 77 (27.7 percent) were complete, another 77 (27.7 percent) were distal fragments, 39 (14.0 percent) were proximal fragments, and the remainder were other fragments. Flake size and weight summaries are shown in Table 7. The average length for complete flakes was 3.5 cm, and the average weight was 3.68 g. When looking at complete flake sizes from the point of view of flake size categories, the size range with the highest number of flakes was the range of 15-20 mm, which consisted of 19 flakes, or 24.7 percent of complete flakes. The second and third highest numbers were in the 30-40 mm and 25-30 mm ranges, having 14 flakes, or 18.2 percent, and 11 flakes, or 14.3 percent, respectively. The amount of cortex on the dorsal face (greater or

Complete Flakes (n-77)	Length	Width	Thickness	Weight
Complete Flakes (II=77)	(cm)	(cm)	(cm)	(g)
Average	3.5	2.4	0.6	3.68
Range	0.7 - 6.8	0.6 - 6.2	0.1 - 2.2	0.04 - 75.15

Table 7. Size and weight summaries of complete flakes in the sample assemblage from site 136 (ASM).

less than 25 percent) was recorded for all complete flakes, including those that had been used as tools. In the case of site 136 (ASM), eight complete flakes out of 77 (10.4 percent) had greater than 25 percent cortex.

The numbers of flakes/flake fragments and shatter in each raw material category is summarized in Table 8. Most flakes and shatter were of medium-grade, Category 3 chert. Category 5 flakes included two of basalt and two of quartzite. One of the Category 3 flakes and a piece of shatter may be of red petrified wood, as identified by USGS geologist George Billingsley, and a Category 4 flake may be of jasper. In total, the flakes made up 70.6 percent of the assemblage sample, and shatter constituted 24.9 percent.

Table 8. Numbers and percentages (in parentheses) of flakes and shatter in each raw material texture category for site 136 (ASM).

	Category 1	Category 2	Category 3	Category 4	Category 5
Flakes	1 (0.3)	21 (7.6)	141 (50.7)	95 (34.2)	20 (7.2)
Shatter	0	3 (3.1)	62 (63.3)	29 (29.5)	4 (4.1)

Platform attributes were recorded for 136 platforms on complete and incomplete flakes from the site. Of these, 86 platforms (63.2 percent) were categorized as simple (single facet) platforms, 36 (26.5 percent) were complex (multi facet) platforms, ten (7.4

percent) of the platforms were cortex, and the remainder were indeterminate. Grinding was present on 24 (17.6 percent) of the platforms, was not present on 93 (68.4 percent), and could not be determined on the remainder. The presence of a lip on the ventral side of the platform was recorded, through which 6 (4.4 percent) were identified as having lips, 138 (94.1 percent) lacked lipping, and two (1.5 percent) were indeterminate.

Size-to-dorsal-scar-count and weight to dorsal scar count ratios were determined for each complete flake. Z-scores of \pm 3.29 were applied to the data sets to eliminate outliers (*p*<.001) (Tabachnick and Fidell 2007). Three outliers were removed from the size ratio and three were removed from the weight ratio, thereby leaving 221 flakes. There was a statistically significant correlation between the size and weight ratios, *r*=.368, *p*<.001, which is expected as the two variables are directly related.

A one-way between-subjects MANOVA was performed with "site" as the independent variable and the two ratios serving as the dependent variables. There was a statistically significant multivariate effect for "site," F(10,428) = 2.691, p < .004, Wilks's $\lambda = .885$. Subsequent univariate ANOVAs with a Bonferroni correction yielded a statistically significant difference among sites for the size ratio, F(5,215) = 5.045, p < .001. The size-to-dorsal-scar-count ratio scores were not significantly different between this site and the other Mt. Trumbull sites, meaning that the dorsal scar count variable was not useful in differentiating a higher amount of early or late stage debitage at this site in relation to the others.

Subsequent Fisher-Hayter range tests (Hayter 1986) indicated that the size-to-dorsalscar-count ratio for two of the sites had significantly higher size ratio scores than did one

of the other sites. The results are discussed more specifically in the section for site AZ:A:12:14(MNA) in Chapter 4.

<u>Use Wear</u>

Forty-one artifacts, including three pieces of shatter, had edge damage which may have been the result of utilization as a tool. This count does not include utilized flakes that were also edge-modified. The flake tools were found evenly distributed across SCUs and Test Pit levels. Twenty-six (63.4 percent) were recovered from surface contexts, five (12.2 percent) were from the 0-10 cm level, three (7.3 percent) were from 10-20 cm, two (4.9 percent) were from 20-30 cm, three were from 30-40 cm, and two were from 40-50 cm. Regarding the number of separate tool edges per artifact, 28 (68.3 percent) had one utilized edge, 10 (24.4 percent) had two edges utilized, and three (7.3 percent) had three utilized edges. As to raw material texture, one (2.4 percent) of the utilized artifacts was of fine-grained, Category 2 chert, 22 (53.7 percent) were of the coursest, Category 5 chert. Seventeen (41.5 percent) of the artifacts in this group were complete flakes. Utilized tools made up 10.4 percent of the sample assemblage.

Raw Material and Tools

The medium-grade, Category 3 chert was the most commonly used material for most tool classes. Three of five bifaces, seven of 11 edge-modified tools, two of three scrapers, all four burins, three of six cores, seven of eight projectile points, and 22 of 41 utilized artifacts were in this raw material category. The other point and bifaces, as well as one utilized flake, were of the finer-grained Category 2 chert. The third scraper, the other three cores, four of the remaining edge-modified flakes, and 16 utilized artifacts

were of the courser, Category 4 chert. The fifth edge-modified flake and two utilized flakes were of Category 5 materials.

Summary

At site AZ:A:12:136 (ASM), platform characteristics and the number of complete flakes with greater than 25 percent cortex tend to show the inhabitants were involved primarily in early to mid-stage lithic production in comparison to the other sites. Early stage reduction is also supported by the large average complete flake size, the tendency of complete flakes to be distributed into relatively large flake size ranges, and the low numbers of flakes with lipping compared to the other sites. The low numbers of latestage debitage may indicate that biface reduction and tool retouch, maintenance, and recycling occurred less often than early-stage work. It should be noted with regard to this site and the others, that the collection method may have caused smaller, late-stage flakes to be missed, in which case the amount of late-stage debitage could be underrepresented.

Three projectile points, five bifaces, six cores, four burins, eight edge-modified flakes, three scrapers, two unifaces, and a number of utilized flakes were part of the sample assemblage, which shows a variety of tasks occurred there. The possible projectile point tip could have been lodged in game that was brought into the site. Two tools from the site had edges that were crushed or ground, which suggests they may have been backed for hand-held utilization (Andrefsky 1998) and used for more than just a brief task. Two artifacts of the Category 4 texture had pot-lidding or red discoloration which may indicate an effort to heat treat the material to improve its concoidal fracturing patterns (Luedtke 1992). At other sites evidence of heat treatment tends to be on finergrained materials.

The fact that a large projectile point was found at a shallower depth than several other smaller arrow points presents a theoretical problem. This indicates that either natural formation processes have substantially affected the stratigraphy at the site or, perhaps someone from a later time period found the point and redeposited it at a later date.

With regard to how intensively tools were used, the number of edge-modified and utilized edges or points on any non-bifacial tool was determined. This number of "functional units" per tool at 136 (ASM) ranged from one to three. More than half of the artifacts included in this calculation (54.9 percent) had only a single tool per artifact. Tools of the finer-grained material did not have more functional units than the other categories, indicating the edges of the finer material was not preferred for use as a tool. Another measure of material use intensity is to determine what percentage of usable flakes were never put to use as tools. The percentage of complete, unused flakes (those not showing edge damage or modification) that were larger than the smallest tool was calculated. For the 136 (ASM) assemblage, 56.9 percent of the flakes that could have potentially been put to use as tools were not used. Two of these were of the Category 2 chert. In addition, the percentage of informal tools (13.9 percent) was higher than that of formal tools (3.0 percent), and four of the six cores recovered were amorphous. Although the presence of only two unused Category 2 flakes could suggest the finestgrade chert was conserved at this site, Category 2 chert tools had similar numbers of functional units to other chert types. Therefore, in general, the lithic assemblage does not show evidence of conservation and matches expectations of a site near plentiful raw material resources.

A total of three pieces of obsidian from the site were sourced. The utilized flake was sourced to Government Mountain, AZ, and the two mid-stage flake fragments were from Partridge Creek (Round Mountain), AZ and from Modena, UT. The obsidian would be considered the most exotic toolstone found at Mt. Trumbull. Although the pieces are fairly small, they do not appear to be from the latest stages of production, nor do they have any cortex, indicating that obsidian tended to be brought into the site perhaps as reduced cores rather than as cobbles or formal tools. The inhabitants of the site also appeared to have access to several obsidian sources, through one or more of the means discussed in Chapter 5. In the case of site 136 (ASM), the expectations for the treatment of exotic toolstone are not met in the assemblage sample.

Some of the chert material recovered from SCU A2 was unusual, and the 10-20 cm level of Test Pit 2 contained chert of uncommon colors for the Mt. Trumbull assemblages and the unidirectional red chert core fragment mentioned above. This raises the possibility that different groups of people may have visited the site, having brought with them some exotic chert toolstone and perhaps a different type of core technology. Other possibilities include regular inhabitants at the site having visited areas that were not commonly part of the normal toolstone procurement rounds or having traded for the unusual materials.

AZ:A:12:14 (MNA)

This site is located at the base of Mt. Trumbull near a road that passes through the Grand Canyon-Parashant National Monument. It is marked with an interpretation sign and is regularly visited by the public, and has been subjected to casual artifact removal from the surface and pot hole digging in architectural features. A sawmill located adjacent to the site produced lumber to build the Church of Jesus Christ of Latter Day Saint temple in St. George, Utah in the early 1900s (United States Department of the Interior 2009).

The prehistoric site has at least eight collapsed rock circles or rooms, with perhaps as many as 20, several of which are contiguous. Both portable groundstone and milling slicks on large boulders were identified. Four carbon 14 dates were recovered from the testing of three possible rooms, and the results dated to A.D. 880-1010, 1000-1170, 1020-1210, and 1160-1280 (Buck and Sakai 2006). A previous site form suggested a Pueblo II time period for the site. One of the rooms contained a floor of irregularly-shaped, flat cobbles, which likely had been covered over with clay. A total of 35 percent (3,191 of 9,212 sherds) of the pottery recovered from the site was corrugated. More than 76 percent of an analyzed pottery sample containing 832 sherds was Moapa Gray Ware. The remaining pottery types were Tusayan Gray Ware - Virgin Series, Shivwits, Shinarump, Tusayan White Ware - Kayenta Series, and Tsegi Orange Ware, in order of decreasing quantity. Of the analyzed pottery sample, 144 sherds were painted, and vessel types included both plain and painted bowls, jars of varying sizes and shapes, some of which were painted, and worked sherds (Buck No date). Painted pottery styles reflected occupation dates ranging from A.D. 800 to perhaps 1240. In addition, the high quantities of corrugated sherds, and the presence of "strongly and perpendicularly everted" jar rims and Tsegi Orange Wares suggest a later period occupation (Perry 2004). Over 1,900 lithics were collected from 250 square meters of surface units, three tested rooms, and 15 test pits.

The required number of surface and subsurface artifacts to reach the sample size for this site was achieved with Surface Collection Units (SCUs) 1 and 2 and Test Pits 1 and 2. Of a total of 430 lithic items, 241 (56 percent) were collected from the SCUs. From the test pits, 43 (10 percent) were from the surface, 89 (20.7 percent) were from 0-10 cm, 34 (7.9 percent) from 10-20 cm, 18 (4.2 percent) from 20-30 cm, and 5 (1.2 percent) from 30-40 cm. The sample assemblage has 275 flakes, 136 pieces of shatter, and 26 tools, including 13 biface fragments, two projectile points, four cores, one scraper, and six retouched flakes, in addition to 58 artifacts with possible use wear. (In each sample assemblage breakdown, artifacts may be counted in more than one category depending on the attributes. For example, a scraper that is on a flake is included in the counts for each above.)

Bifaces

Four projectile points were recovered from the analyzed sample (Table 9, Figure7): three Rose Spring corner-notched types and a Parowan point. The complete point (designated "A") was made of the fine, Category 2 chert and was recovered from the 10-20 cm level of Test Pit 2. The Rose Spring designated "B" was of the medium grade, Category 3 chert and was found in SCU 1. The Parowan point, made of Category 3 chert, was collected from the 10-20 cm level of Test Pit 2, and Rose Spring Point "C" was of Category 2 chert and recovered from Test Pit 1 in the 10-20 cm level. The Rose Spring contracting stem points have a date range of approximately A.D. 500-700 to A.D. 1300, while the Parowan point dates to between A.D. 950 and A.D. 1150. The four projectile points made up 0.94 percent of the assemblage sample.

Tuno	Condition	Drovenience	Max	Max	Max	Weight
Туре	Condition	Flovemence	MaxMaxMLengthWidthThick2.41.60n/an/ann/a1.80.		Thickness	(g)
Rose Spring CN (A)	Complete	TP2, Level 2	2.4	1.6	0.3	1.0
Rose Spring CN (B)	Incomplete	SCU 1	n/a	n/a	n/a	n/a
Parowan Point	Incomplete	TP2, Level 2	n/a	1.8	0.35	n/a
Rose Spring CN (C)	Incomplete	TP1, Level 2	n/a	1.6	0.3	n/a

Table 9. Measurement and weight data for analyzed projectile points from site AZ:A:12:14 (MNA).

CN=corner-notched; SCU=surface collection unit; TP=test pit; n/a=not available.

Thirteen other biface fragments were recorded in the analysis and divided into the following stage categories: three were Stage II, four Stage III, four Stage IV, and two were indeterminate. Five bifaces were of fine chert, six were made of a medium chert, and two were crafted from a course chert. All but one were recovered from surface



Figure 7. Four projectile points from the AZ:A:12:14 (MNA) sample assemblage.

contexts. The proximal ends were missing from 12 of the 13 tools. Of the 12 broken tools, five were medial/lateral fragments, five were distal fragments, one was a distal/medial fragment, and one was an indeterminate section. These 13 bifaces made up 3.0 percent of the assemblage sample.

Cores

Four cores (three multidirectional and one indeterminate) were recorded in the sample (Table 10). The core from Test Pit 1 had greater than 25 percent cortex on one side. The largest core, weighing over 55 g, was primarily of Category 3 chert, and the remainder were of Category 4 material. A small red area on one of the cores may be an indicator of heat treatment. Cores made up 0.9 percent of the sample assemblage.

		Texture			#Neg			Weight	
Unit ¹	Depth ²	Category	Type ³	Prep ⁴	Scars ⁵	#Plat ⁶	MaxDim ⁷	(g)	Por ⁸
SCU2	S	3	MUL	UN	7	1	3.5	12.71	COM
SCU2	S	3	MUL	PP	8	1	5.1	55.63	COM
TP1	L 1	3	MUL	PP	7	6	5.1	42.88	COM
TP2	L 1	4	IND	UN	2	2	4.1	19.44	FRAG

Table 10. Attributes of cores recovered from 14 (MNA) in order of unit and depth.

¹ SCU=surface collection unit; TP=test pit.

² S=surface; L=level.

³ IND=indeterminate; MUL=multidirectional; UNI=unidirectional.

⁴ Prep=preparation type; PP=partially prepared; UN=unprepared.

⁵ Number of recognizable negative flake scars.

⁶ Number of recognizable platforms.

⁷ Maximum dimension (cm).

⁸ Portion: COM=complete; FRAG=fragment; IND=indeterminate.

Edge-modified Tools

Seven edge-modified tools were recorded in the lithics sample (Table 11), one of

which was complete. One of these had at least one sufficiently angled edge to be

classified as a scraper. It had an 86 degree angle and was additionally utilized on another

unmodified edge. Of the other six edge-modified flakes, four had one modified edge, and

two had two modified edges. In addition, all had use wear present on at least one other

edge. The single complete edge-modified flake measured 1.8 cm in length, 1.7 cm wide,

0.4 cm thick, and weighed 1.3 grams. The proximal ends were missing from the scraper and two of the edge-modified flakes. The other two edge-modified fragments were a proximal end and a lateral edge. Two of the edge-modified flakes on the surface were made from Category 2 chert, and the remainder were of Category 3 chert. The edge-modified flakes made up 1.6 percent of the assemblage sample.

Tool TypeSurfaceLevel 1Level 2Level 3Level 4Edge-modified flakes3211Scrapers1

Table 11. Edge-modified tools at site AZ:A:12:14 (MNA).

Debitage

The assemblage sample included 275 flakes and 136 pieces of shatter (these numbers include flakes and shatter that were made into or used as tools but still retained recognizable flake or shatter properties). Of the flakes, 60 (21.8 percent) were complete, 82 (29.8 percent) were distal fragments, 67 (24.4 percent) were proximal fragments, and the remainder were other fragments. The average length of complete flakes was 1.75 cm, and the average weight 7.85 cm (Table 12).

Table 12.	Size and weight	ght summaries	of comp	lete fla	akes in	the sam	ple asse	mblage	from
site AZ:A	:12:14 (MNA)).							

Complete Flakes (n=60)	Length	Width	Thickness	Weight
Complete Flakes (II-00)	(cm)	(cm)	(cm)	(g)
Average	1.75	1.6	0.43	7.85
Range	0.6 - 5.3	0.6 - 5.2	0.1 - 2.2	0.03 - 361.1

When looking at complete flake sizes from the point of view of flake-size categories, the size range with the highest number of flakes was the range of 10-15 mm, which consisted of 17 flakes, or 28.3 percent of complete flakes. The second and third highest numbers were in the 15-20 mm and 20-25 mm ranges, each having 13 flakes, or 21.7 percent each. The amount of cortex on the dorsal face (greater or less than 25 percent) was recorded for all complete flakes, including tools. In the case of site AZ:A:12:14(MNA), three complete flakes out of 62 (4.8 percent) had greater than 25 percent cortex. The flake and shatter raw material categories are summarized in Table 13.

Table 13. Numbers and percentages (in parentheses) of flakes and shatter in each raw material texture category for site AZ:A:12:14 (MNA).

	Category 1	Category 2	Category 3	Category 4	Category 5
Flakes	0	49 (17.8)	185 (67.3)	38 (13.8)	3 (1.1)
Shatter	0	22 (16.2)	85 (62.5)	28 (20.6)	1 (0.7)

One of the Category 2 flakes was made of red petrified wood (as identified by USGS geologist George Billingsley). The largest percentages of both flakes and shatter were of the mid-grade, Category 3 chert. One of the Category 5 flakes was of basalt. The flakes made up 64.0 percent of the assemblage sample, and shatter constituted 31.6 percent.

Platform attributes were recorded for 121 platforms on complete and incomplete flakes from the site. Of these, 60 platforms (49.6 percent) were categorized as simple platforms, 50 (41.3 percent) were complex platforms, three (2.5 percent) of the platforms were cortex, and the remainder were indeterminate. Grinding was present on 24 (19.8 percent) of the platforms, was not present on 77 (63.6 percent), and could not be determined on 20 (16.5 percent). The presence of a lip on the ventral side of the platform was recorded; however, the lip was not objectively measured, and I believe there was some bias on my part such that I became more conservative in positively identifying a lip as the analysis progressed. As 14 (MNA) was the first site analyzed, the higher number of platforms with lips at this site in comparison to the others may not be accurate. Of the 121 platforms at site 14 (MNA), 23 (19 percent) were identified as having lips, 90 (74.4 percent) lacked lipping, and eight (6.6 percent) were indeterminate.

The size-to-dorsal-scar-count ratio indicated that sites AZ:A:12:204 (BLM) and AZ:A:12:214 (ASM) had significantly higher size ratio scores than did site AZ:A:12:14 (MNA), ps<.04. In other words, the sample assemblage from site AZ:A:12:14 (MNA) has a lower number of early stage debitage versus late stage debitage, as determined by the size-to-dorsal-scar-count ratio, than do sites AZ:A:12:204 (BLM) or AZ:A:12:214 (ASM). The ratio was not useful in differentiating a higher amount of early or late stage debitage among 14 (MNA) and the other three sites included in the project.

Use Wear

Fifty-eight artifacts, including six pieces of shatter and two cores, had edge damage which may have been the result of utilization as a tool. Most, 33 (56.9 percent), were from the surface, 16 (27.6 percent) were from the 0-10 cm level, seven were from 10-20 cm, and one each was recovered from the 20-30 and 30-40 cm levels. Thirty-six of 58 (62.1 percent) had one utilized edge, 17 (29.3 percent) had two edges utilized, seven artifacts (12.1 percent) had three utilized edges, and one (1.7 percent) had four utilized edges. On two flakes the angles of the utilized edges over 75 degrees indicate the tools may have been used as scrapers. Both had possible use wear on angles of approximately

82 degrees. One piece of shatter had its use wear on two edges with approximate 90 degree angles. With regard to raw material texture, 13 (22.4 percent) of the utilized artifacts were of fine-grained, Category 2 chert, 29 (50.0 percent) were of Category 3 chert, 15 (25.9 percent) were of Category 4 chert, and one (1.7 percent) was of the coursest, Category 5 chert. Sixteen (27.6 percent) of the tools were on complete flakes. Utilized tools made up 13.5 percent of the sample assemblage.

Raw Material and Tools

The medium-grade, Category 3 chert was the most common material of which tools were found, but there was not a clear preference for this material over the other cherts for tools in the sample at this site. Six of the 13 bifaces, two of four projectile points, three of four cores, four of six edge-modified flakes, one of three scrapers, and 28 of 54 utilized artifacts were of this material group. With regard to the remaining bifaces, five were of the finer, Category 2 chert, one was of Category 4 chert, and one was of the coursest, Category 5 chert. The other two projectile points, two edge-modified flakes, and 13 utilized artifacts were of the Category 2 chert. The additional two scrapers, the fourth core, and 12 utilized artifacts were of Category 4 chert.

Summary

The lithic assemblage at site AZ:A:12:14 (MNA) indicates more late-stage production activity in comparison to the other sites. This site has the lowest percentages of simple/cortex platforms, platforms with lipping, and complete flakes with less than 25 percent cortex. In addition, the size-to-dorsal-scar-count ratio indicates a comparatively significant trend towards late-stage debitage. Site 14 (MNA) also has the smallest average complete flake size, and flake sizes are primarily distributed among a lower

range of size groups than the other sites. Higher levels of late-stage production are indicators more biface tool manufacturing, and perhaps more tool retouch, maintenance, and recycling occurred here. The presence of only a few cores at the site may suggest that flakes were removed from cores prior to be brought into the site.

Utilized flakes were recovered in numerous collection units, with a concentration located in SCU 2. As utilized flakes are thought to be left in the locations in which they were used, the area in and around SCU 2 may have been a place where people grouped to carry out similar tasks, at least during one occupation, assuming that natural processes have not greatly affected the spatial location of the flakes. SCU 2 also contained five biface fragments, one core, three edge-modified flakes, and numerous flakes and pieces of shatter. Thus, it appears that a wide range of activities occurred in this concentrated area in addition to tool production.

A similar trend of wide ranging activities also occurs over the site in general. The entire sample assemblage included 13 bifaces, four projectile points, four cores, five edge-modified flakes, and four scrapers. Pot-lidding or red clouding on seven artifacts, most frequently those of the medium-grade Cagetory 3 chert, suggest heat treatment was used to improve tool production success.

This assemblage contained a larger percentage of tools made from the finer-grade, Category 2 material than the other sites. The percentage at this site was 26.2 percent, while the others ranged from 4.8 to 16.1 percent. The inhabitants of this site may have, at least periodically, had a preference for using the higher quality raw material for tools.

Pertaining to how intensively toolstone was used in general, the number of functional units per tool at 14 (MNA) ranged from one to five. Greater than half of the artifacts

included in this calculation (56.3 percent) had only a single tool per artifact. There does not appear to be an association between number of functional units per tool and material type. Also at this site, 37.2 percent of the collected complete flakes that could have been used as tools (i.e., were larger than the smallest complete tool size) did not appear to be utilized. None of the unused flakes were of the Category 2 chert, which may be an indication of some conservation of the finer-grained material. The sample included 15.1 percent informal tools compared to 4 percent formal tools, and three of the four cores were amorphous, which is expected given the close proximity to abundant raw material sources. However, the site shows a slight trend toward raw material conservation in that a higher percentage of late-stage debitage is present and the percentage of unused flakes is relatively low compared to the other sites. No obsidian was recovered from this site.

AZ:A:12:204 (BLM)

AZ:A:12:204 (BLM) is different from the other sites in that it has no surface architecture and the site assemblage has no corrugated or painted ceramics. It is one of the group of sites southeast of Mt. Trumbull. The site may have been used less intensively, during an earlier time period, or for a different purpose than the others. It encompasses a light artifact scatter and five circular depressions measuring about 4 to 5 m in diameter which could represent pithouse habitation structures. The artifact scatter covers an area of approximately 1,000 m². One carbon sample recovered by augering returned a date of A.D. 810-890 (Buck 2005). The 106 pottery sherds were primarily Moapa Gray Ware. Sixty-five flaked lithics were collected from 200 square meters of surface units and three test pits. One of the test pits made contact with a compact clay surface. During a 1990 project the site was categorized as having a Basketmaker III to Pueblo I period occupation (Buck 2006).

The number of lithic artifacts available did not reach the preferred sample size for this site. Artifacts were recovered from Surface Collection Units (SCUs) A1, 2, 4, 5, 7, 8, 9, and 10, Units B2, 4, 5, 7, 8, and 9 (no lithic artifacts were recovered from units not listed) and Test Pits 1 through 3. Of a total of 65 lithic items, 33 (50.8 percent) were collected from the SCUs. From the test pits, three (4.6 percent) were from the surface, 16 (24.6 percent) were from 0-10 cm, eight (12.3 percent) from 10-20 cm, and five (7.7 percent) were from 20-30 cm. The sample assemblage includes five biface fragments, two projectile points, one core, one scraper, one burin, one other edge-modified flake, 13 possible utilized tools, 35 unmodified/unused flakes, and seven pieces of unmodified/unused shatter.

Bifaces

Two projectile point fragments were recovered from the analyzed sample (Table 14, Figure 8). A small contracting stem point from SCU A9 was of Category 3 chert. A large, partially side-notched biface, also of Category 3 chert, that appeared to have had shoulder work started on one edge prior to production failure, was found in SCU A7. Although the point base found does not precisely fit the morphology of a Rose Spring contracting stem type, it could be from a similar time period, which for the Rose Spring ranges from about A.D. 500-700 to A.D. 1300. The two projectile point fragments made up 3.1 percent of the assemblage sample.

Туре	Condition	Provenience	Max Length	Max Width	Max Thickness	Weight (g)
Contracting Stem Point	Incomplete	SCU A9	n/a	1.2	0.4	n/a
Side-notched Point	Incomplete	SCU A7	n/a	1.9	0.5	n/a
SCII_aurfaga collect	on units n/o-r	at available				

Table 14. Measurement and weight data for analyzed projectile points from site AZ:A:12:204 (BLM).

SCU=surface collection unit; n/a=not available.

Another five biface fragments were recorded in the analysis. One was a Stage I fragment, one was Stage II, two were Stage III, and the last was indeterminate. One of the Stage III fragments was of the Category 2 chert, and the remainder were of Category 3 material. The indeterminate stage fragment was from the 20-30 cm level, while the other four bifaces were recovered from surface contexts. One of the fragments was a proximal/medial portion, and the other four were of indeterminate segments. The five biface tools made up 7.7 percent of the assemblage sample.



Figure 8. Two projectile points from site AZ:A:12:204 (BLM).

<u>Cores</u>

A complete, unprepared, multidirectional core of Category 3 chert was recovered from SCU A4. It had seven negative flake scars and one identifiable platform. The maximum dimension was 3.9 cm, and it weighed 11.45 g.

Edge-modified Tools

A total of three edge-modified tools were recorded in the lithics sample (Table 15), all of Category 3 chert. The medial and distal portion of a burin, modified on two edges, was collected from SCU A4. A large scraper fragment having a modified edge angle of 83 degrees was in the 20-30 cm level of Test Pit 2, and a third flake fragment with retouch on two edges was found in SCU B5. Edge-modified tools made up 4.6 percent of the sample assemblage.

 Table 15. Edge-modified tools at site AZ:A:12:204 (BLM).

 Tool Type
 Surface

Tool Type	Surface	Level 1	Level 2	Level 3
Burins	1			
Edge-modified flakes	1			
Scrapers				1

Debitage

The assemblage sample included 49 flakes and eight pieces of shatter (these numbers include flakes and shatter that were made into, or used, as tools but still retained recognizable flake or shatter properties). Of the flakes, nine (18.4 percent) were complete, 12 (24.5 percent) were distal fragments, 13 (26.5 percent) were proximal fragments, and the remainder were other fragments. Complete flake sizes and weights are summarized in Table 16. When looking at complete flake sizes from the point of

Complete Flakes (n=0)	Length	Width	Thickness	Weight
Complete Flakes (II=9)	(cm)	(cm)	(cm)	(g)
Average	2.3	2.1	0.5	3.17
Range	0.7 - 3.6	0.5 - 3.2	0.2 - 0.7	0.05 - 7.33

Table 16. Size and weight summaries of complete flakes in the sample assemblage from site 204 (BLM).

view of flake size categories, the size range with the highest number of flakes was 30-40 mm, having four flakes, or 44.4 percent of the complete flakes. Only one flake of 9 (11.1 percent) had greater than 25 percent cortex. The raw material categories for flakes and shatter are shown in Table 17. Two of the Category 5 flakes were basalt. The flakes made up 75.4 percent of the assemblage sample, and shatter constituted 12.3 percent.

Table 17. Numbers and percentages (in parentheses) of flakes and shatter in each raw material texture category for site AZ:A:12:204 (BLM).

	Category 1	Category 2	Category 3	Category 4	Category 5
Flakes	0	0	36 (73.5)	10 (20.4)	3 (6.1)
Shatter	0	1 (12.5)	4 (50.0)	3 (37.5)	0

Platform attributes were recorded for 29 platforms on complete and incomplete flakes from the site. Of these, 21 platforms (72.4 percent) were categorized as simple platforms, five (17.2 percent) were complex platforms, and three (10.3 percent) of the platforms were cortex. Grinding was present on five (17.2 percent) of the platforms, was not present on 21 (72.4 percent), and could not be determined on three (10.3 percent). Of the 29 platforms, six (20.7 percent) were identified as having lips.

The size-to-dorsal-scar count ratio indicated that site AZ:A:12:204 (BLM) had a significantly higher size ratio score than did site AZ:A:12:14 (MNA). That is, the sample

assemblage from site AZ:A:12:204 (BLM) has a higher number of early stage debitage, as determined by the size-to-dorsal-scar-count ratio, than does site AZ:A:12:14 (MNA). It is unknown whether the small sample size from site 204 (BLM) has impacted this result.

<u>Use Wear</u>

Thirteen artifacts, including one piece of shatter and the core, had edge damage which may have been the result of utilization as a tool. Nine (69.2 percent) were recovered from surface contexts and four from subsurface layers. Of these, seven (53.9 percent) had one utilized edge, three (23.0 percent) had two edges utilized, and another three had three utilized edges, including the piece of shatter. One early stage flake had been backed on the edge opposite from the use damage. Utilized artifacts were also more commonly found of the Category 3 chert (nine of 13 utilized tools, or 69.2 percent). The utilized piece of shatter was of Category 2 material, and three utilized flakes (23.1 percent) were of Category 4 materials. Utilized tools made up 20.0 percent of the sample assemblage.

Raw Material and Tools

The medium-grade, Category 3 chert was the most commonly used material for tool classes. All of the edge-modified and all but one of the formal tools were of Category 3 chert, as well as nine utilized artifacts. A single biface fragment and a utilized piece of shatter were of Category 2 material. The only Category 4 artifacts were three utilized flakes.

<u>Summary</u>

Given the small sample size (65 artifacts) collected from site AZ:A:12:204 (BLM), the ability to interpret activities at the site related to lithic production is limited. The sizeto-dorsal-scar-count ratio, complete flake size, and platform characteristics suggest early and mid-stage production in comparison to the other sites.

With regard to other site activities, the presence of the proximal end of a projectile point and another biface may indicate that equipment was rehafted at the site. Utilized flakes were recovered from several collection units. In addition, the assemblage contained five biface fragments, another projectile point, one core, one scraper, one burin, and one other edge-modified flake, which reflect the variety of tasks that may have been performed here. Given the small size of this site's sample assemblage, it is somewhat surprising that as many tool types are present here as there are at the site with the largest sample size (14 (MNA)). This would suggest that similar activities occurred at both locations, despite the lack of architecture at 204 (BLM), the smaller site size, and the probable shorter time span of occupation.

With reference to how intensively tools were used, the number of functional units per tool at 204 (BLM) ranged from one to three. A total of 44.4 percent (eight) of the artifacts included in this calculation had only a single tool per artifact, followed by 38.9 percent having two tools, and 16.7 percent having three tools. Also at this site, 66.7 percent of the collected complete flakes that could have been used as tools (note that at 204 (BLM) this refers to only four out of six flakes) did not appear to be utilized. There was no apparent relationship between the number of functional units per tool and material type. The number of complete tools was so low that it was difficult to recognize a

relationship between unused tools and material type with any certainty. As was the case with determining stages of production activity, the low sample size for this site hinders efforts to interpret intensity of raw material use. No obsidian was recovered from the site.

AZ:A:12:214 (ASM)

This site is one of those in the group southeast of Mt. Trumbull and has approximately seven rooms, three of which appear to be individual structures, and the other four seem to be split into two adjacent rooms each. The room features may be part of habitation structures or field houses. Test Pit #2, located in a likely midden area to the northeast of the room features, contained the bulk of the subsurface artifacts recovered. A carbon sample from the second level of Test Pit #5 resulted in a date of A.D. 640-770 (Buck 2006). A total of 18.2 percent (152 of 837 sherds) of the pottery collected from the site was corrugated. Four painted sherds were reported, but have not been analyzed. Over 180 lithics were collected from 344 square meters of surface units and five test pits.

The number of lithic artifacts available did not reach the preferred sample size for this site. Surface Collection Units (SCUs) A1, 2, 3, 5, 7, 8, and 10, Units B3, 4, 5, 6, 7, 8, 9, 11, and 12 (no lithic artifacts were recovered from units not listed) and Test Pits 1 through 5. Of a total of 181 lithic items, 123 (68.0 percent) were collected from the SCUs. From the test pits, 17 (9.4 percent) were from the surface, 36 (19.9 percent) were from 0-10 cm, and five (2.8 percent) from 10-20 cm. While all test pits produced lithics from the first level, only in Test Pits 2 and 3 were lithic artifacts recovered from the 10-20 cm level. The sample assemblage included two biface fragments, a drill fragment,

three small projectile point fragments, two cores, one scraper, two other edge-modified flakes besides the scraper, 24 possible utilized tools (including one scraper), 93 unmodified/unused flakes, and 53 pieces of unmodified/unused shatter. The modified scraper and one utilized flake had evidence of possible use as burins.

Bifaces

Three projectile point fragments were recovered from the analyzed sample (Table 18). The base fragment of a Parowan basal-notched point from SCU B9 is of Category 3 chert (Figure 9). Its extremities are a dark red, while the interior is more orange, which could be an indication of heat treatment. The small Eastgate contracting stem point from the 0-10 cm level of Test Pit 4 is also of Category 3 chert and may have been reworked into its rather squat shape. A partial ear fragment of Category 2 chert (not pictured) was recovered from SCU B9. The Eastgate point has a chronology of about A.D. 600 to 1300. Parowan points are thought to be later, appearing near A.D. 950 and ending

 Table 18. Measurement and weight data for analyzed projectile points from site

 AZ:A:12:214 (ASM).

Туре	Condition	Provenience	Max Length	Max Width	Max Thickness	Weight (g)
Parowan	Incomplete	TP1, Level 5	n/a	1.3	0.4	n/a
Eastgate	Incomplete	TP1, Level 3	n/a	1.4	0.2	n/a
Partial ear fragment	Incomplete	SCU 59	n/a	n/a	n/a	n/a

CS=contracting stem; SCU=surface collection unit; TP=test pit; n/a=not available.



Figure 9. Two of three projectile point fragments from site AZ:A:12:214 (ASM).

approximately A.D. 1150. The three projectile point fragments made up 1.7 percent of the assemblage sample.

Another two Stage IV biface fragments were recorded in the analysis. One was a distal fragment and the other was the medial segment of a drill. Both were of the medium-grade, Category 3 chert, and all were recovered from surface contexts. These biface tools made up 1.1 percent of the assemblage sample.

Cores

Two unprepared, multidirectional cores were recorded in the sample and are detailed

in Table 19. The cores made up 1.1 percent of the sample assemblage.

Table 19. Attributes of cores recovered from site AZ:A:12:214 (ASM).

		Texture	2	1	-		7		0
Unit	Depth ²	Category	Type ³	Prep ⁴	#Neg Sc ³	#Plat [°]	MaxDim'	Weight (g)	Portion [®]
SCUB9	S	2	MUL	UN	4	3	4.15	17.47	COM
TP5	L 1	3	MUL	UN	3	2	3.6	17.15	FRAG

¹ SCU=surface collection unit; TP=test pit.

² S=surface; L=level.

³ IND=indeterminate; MUL=multidirectional; UNI=unidirectional.

⁴ Prep=preparation type; PP=partially prepared; UN=unprepared.

⁵ Number of recognizable negative flake scars.

⁶ Number of recognizable platforms.

⁷ Maximum dimension (cm).

⁸COM=complete; FRAG=fragment; IND=indeterminate.

Edge-modified Tools

A total of three edge-modified tools were recorded in the lithics sample (Table 20),

all distal fragments of Category 3 chert flakes and from surface contexts. A burin from

SCU B9 also had a modified angle of 80 degrees, which places it in the category of a

scraper, and a second edge appeared to be polished as a result of use. The distal tip of a

flake from Test Pit 1 had been modified into a rounded edge on one face, and the third tool was from Test Pit 3. Edge-modified tools made up 1.7 percent of the sample assemblage.

Table 20. Edge-modified tools found at site AZ:A:12:214 (ASM).

Tool Type	Surface	Level 1	Level 2				
Edge-modified flakes	2						
Scrapers	1						

Debitage

The assemblage sample included 118 flakes and 55 pieces of shatter (including flakes and shatter that were made into or used as tools). Of the flakes, 25 (13.8 percent) were complete, 32 (17.7 percent) were distal fragments, 33 (18.2 percent) were proximal fragments, and the remainder were other fragments. Complete flake lengths averaged 2.6 cm, and weight averaged 5.31 g (Table 21).

Table 21. Size and weight summaries of complete flakes in the sample assemblage from site AZ:A:12:214 (ASM).

Complete Flakes (n-25)	Length	Width	Thickness	Weight	
Complete Flakes (II=23)	(cm)	(cm)	(cm)	(g)	
Average	2.6	2.5	0.7	5.31	
Range	1.1 - 4.6	1.1 - 5.0	0.3 - 1.2	0.5 - 20.85	

When looking at complete flake size categories, the size ranges with the highest number of flakes were the ranges of 15-20 mm, 20-25 mm, and 30-40 mm, each consisting of five flakes, or 20.0 percent each of the complete flakes. Five complete flakes (20.8 percent) had greater than 25 percent cortex. Table 22 presents the raw

material categories making up flakes, including fragments, and pieces of shatter. One of the Category 5 flakes was basalt. The flakes made up 65.2 percent of the assemblage sample, and shatter constituted 30.4 percent.

Table 22. Numbers and percentages (in parentheses) of flakes and shatter in each raw material texture category for site AZ:A:12:214 (ASM).

	Category 1	Category 2	Category 3	Category 4	Category 5
Flakes	0	11 (9.3)	42 (35.6)	41 (34.8)	24 (20.3)
Shatter	1 (1.8)	6 (10.9)	22 (40.0)	18 (32.7)	8 (14.6)

Platform attributes were recorded for 65 platforms on complete and incomplete flakes from the site. Of these, 44 platforms (67.7 percent) were categorized as simple platforms, 16 (24.6 percent) were complex platforms, two (3.1 percent) of the platforms were cortex, and the remainder were indeterminate. Grinding was present on six (9.2 percent) of the platforms, was not present on 54 (83.1 percent), and could not be determined on five (7.7 percent). Of the 65 platforms, four (6.2 percent) were identified as having lips, 57 (87.6 percent) lacked lipping, and four (6.2 percent) were indeterminate.

The size-to-dorsal-scar-count ratio indicated that site AZ:A:12:214 (ASM) had a significantly higher size ratio score than did site AZ:A:12:14 (MNA). That is to say, the sample assemblage from site AZ:A:12:214 (ASM) had a higher number of early stage debitage, as determined by the size-to-dorsal-scar-count ratio, than does site AZ:A:12:14 (MNA).

Use Wear

Twenty-four artifacts, including two pieces of shatter, had edge damage which may have been the result of utilization as a tool. Twenty-one (87.5 percent) were recovered from surface contexts and three from subsurface layers. Of these, 17 (70.8 percent) had one utilized edge, including the two pieces of shatter, 5 (20.8 percent) had two edges utilized, one (4.2 percent) had three utilized edges, and one (4.2 percent) had four utilized edges. A flake fragment from the surface of Test Pit 1 had a utilized edge with an 88 degree angle, as well as use wear on a fracture that had an 82 degree angle, indicating possible use as a scraper. One utilized flake also had a point with associated damage that could indicate it had been used as a burin. With regard to texture, four tools (16.7 percent) were from Category 2 chert, 11 (45.8 percent) were from Category 3 chert, four (16.7 percent) from Category 4 chert, and five (20.8 percent) were from Category 5 chert. Utilized tools made up 8.6 percent of the sample assemblage.

Raw Material and Tools

The medium-grade, Category 3 chert was the most commonly used material for tool classes. Both bifaces, the drill, both edge-modified flakes, one of the two scrapers, a burin, one of the two cores, two of the three projectile points, and ten utilized artifacts were in this raw material category. One core, one projectile point, and four utilized flakes were of Category 2 chert. The other scraper, as well as three utilized flakes were made of Category 4 materials, and five utilized flakes were of the coursest, Category 5 materials.

Summary Summary

The assemblage at site AZ:A:12:214 (ASM) appears to represent primarily early and mid-stage lithic production work. Platform attributes indicate an intermediate level of early stage activity in comparison to the other sites, but the high percentage of complete flakes with greater than 25 percent cortex, the low percentages of lipping on platforms

and small flakes, and the size-to-dorsal-scar-count ratio suggest higher levels of early stage activity.

With regard to other site activities, the presence of proximal ends of two projectile points indicates hunting equipment may have been rehafted here. The utilized flakes were more frequently found in SCUs placed outside the main part of the site. It is unknown, however, if this is the result of a different activity pattern or due to noncultural formation processes. In addition to the utilized flakes, other tools in the assemblage included two biface fragments, a drill fragment, three small projectile points, two cores, one scraper also having evidence of polish, and two other edge-modified flakes (one of which had a tip that had been formed into a rounded shape), suggesting a variety of tasks were carried out at the site. Low percentages of late-stage debitage and small-sized debitage indicate biface production and tool retouch, maintenance, and recycling were a lower priority. One piece of Category 3 shatter exhibited possible potlidding, an indicator of heat treatment to improve the conchoidal fracturing of the stone.

With regard to how intensively raw materials were used, the functional units per tool on 27 artifacts at PB04 ranged from one to four. Two-thirds of the artifacts included in this group (66.7 percent) had only a single tool per artifact. Also related to intensity of use, 42.1 percent of the collected complete flakes that could have been used as tools did not appear to be utilized. Four of the 27 non-bifacial tools were of Category 2 material. Two of these had two functional units and one had four. None of the unused complete flakes was of Category 2 material, but it is also the case that only one complete flake in the entire sample assemblage was of the finest chert, such that this measurement may be inconsequential. Therefore, the evidence that finer-grained materials were conserved is weak. Several of the utilized flakes were of the courser-grained materials; thus an extremely sharp edge does not appear to have been the top priority for informal tool users at this site. The low levels of late-stage production debitage, the presence of roughly three times as many informal tools as formal tools, and the amorphous cores imply that toolstone was not intensively used in general.

A total of two pieces of obsidian from the site were sourced. A complete drill was sourced to Black Tank in Arizona, and a piece of shatter was from Partridge Creek (Round Mountain), AZ. The shatter had a maximum dimension of 2.5 cm and therefore would have come from a core that size or larger. Its presence indicates at least mid-stage production activity on obsidian occurred at the site.

AZ:A:12:30 (BLM)

Located among the group of sites southeast of Mt. Trumbull, the primary feature at this site is a C-shaped pueblo with approximately 15 collapsed rooms. When the site was first recorded it was reported to have an artifact scatter covering approximately 125 x 100 m and containing thousands of Moapa Gray Ware, North Creek Gray Ware, and Shinarump sherds, as well as one stemmed projectile point. A carbon 14 date from a corn kernel recovered by augering at a depth of 65 cm during the Mt. Trumbull field school gave a result of A.D. 1110 to 1190 (Buck 2005). A total of 8.7 percent (451 of 5,188 sherds) of the pottery recovered from the site was corrugated. More than 170 sherds were painted, but the design styles have not yet been determined. Over 600 lithics were collected from 260 square meters of surface units and 3 test pits.

The required number of surface and subsurface artifacts to reach the sample size for this site was achieved with Surface Collection Units (SCUs) A1 through A12 and Test Pits 1 and 2. Of a total of 314 lithic items, 151 (48.1 percent) were collected from the SCUs. From the test pits, 13 (4.1 percent) were from the surface, 48 (15.3 percent) were from 0-10 cm, 27 (8.6 percent) from 10-20 cm, 10 (3.2 percent) from 20-30 cm, and 16 (5.1 percent) from 30-40 cm, 23 (7.3 percent) from 40-50 cm, and 26 (8.3 percent) were from 50-60 cm. The sample assemblage has 32 tools: 11 bifaces (one complete and ten fragments, including one drill), two projectile points, one core, five possible burins, 13 retouched flakes, and 27 artifacts with possible use wear, in addition to 244 flakes and 55 pieces of shatter.

Bifaces

Two projectile points were recovered from the analyzed sample (Table 23, Figure 10), both made from Category 3 chert and found at subsurface levels of Test Pit 1. The complete point, a Rose Spring corner-notched point, was recovered from the 40-50 cm level. The other point, a Parowan from the 20-30 cm level, is missing the extreme end of its base. The Rose Spring point and the Parowan point place the site in the broad time range of about A.D. 500-700 to A.D. 1300 and A.D. 950 to A.D. 1150, respectively. The two projectile points made up 0.6 percent of the assemblage sample.

Ten other biface fragments and one complete biface were recorded in the analysis and divided into the following stage categories: two were Stage II, two Stage III, four Stage IV, and three were indeterminate. One biface fragment was of fine, Category 2 chert and ten were of the medium-grade, Category 3 chert. Seven were recovered from surface contexts and four from test pits. Of the fragments, two were proximal ends, five were

distal ends, and three were indeterminate sections. A fragment from the 30-40 cm level of Test Pit 1 was the distal end of a drill. A Stage III biface from SCU A2 had fractured at the distal end resulting in a point that could have been used as a burin, although use wear was not evident. A small, Stage IV biface fragment from SCU A3 had a clear notch made on one edge, but the remaining intact edges indicated it had not been a projectile

Table 23. Measurement and weight data for analyzed projectile points from site AZ:A:12:30 (BLM).

Tuna	Condition	Drovanianaa	Max	Max	Max	Weight		
Type	Condition	Flovemence	Length	Width	Thickness	(g)		
Rose Spring CN	Complete	TP1, Level 5	2.6	1.3	0.3	0.91		
Parowan Point	Almost Complete	TP1, Level 3	2.3	1.7	0.4	1.15		

CN=corner notched; TP=test pit.



Figure 10. Two projectile points from AZ:A:12:30 (BLM).

point. The shape that this tool would have been in its complete form is unknown. The tip of a Category 3 chert tool appeared to be more of a triface than a biface. These 11 bifaces made up 3.5 percent of the assemblage sample.
Cores

One core was recorded in the sample, recovered from the 10-20 cm level of Test Pit 2. The fragment was an unprepared, multidirectional core of medium-grade, Category 3 chert with a maximum dimension of 3.6 cm, weighing 8.55 g, and having at least three identifiable flake removals. No platforms were clearly visible. The core made up 0.3 percent of the sample assemblage.

Edge-modified Tools

A total of twenty edge-modified tools were recorded in the lithics sample (Table 24), three of which were complete. Seven tools, all of Category 3 chert, had points and could be classified as burins. Two of these were from surface contexts, one was from Test Pit 1, and four were from Test Pit 2. One burin was on a piece of shatter and the remainder were on flakes. Five burins had possible use wear on two to three tool edges.

Two tools made of Category 3 chert had three faces. Both were classified as burins, but also had edge-modification and possible use wear. They were recovered from the 0-10 cm level of Test Pit 2. The first had retouch on one edge and possible use wear on two edges. On the other, both edges of one face were retouched all the way up to the point, but the other two faces appeared to be untouched.

Thirteen flakes, four of which were from the surface and eight from subsurface levels, exhibited other edge-modification on one to three margins. Ten of these were broken. Two of the edge-modified tools were made of the high-quality, Category 2 chert, eight were of the Category 3 chert, two were of Category 4 chert, and one was made up of primarily Category 5 chert. Seven edge-modified tools also had possible use wear damage on one to three other edges. Although some of these tools had edge angles up to

Table 24. Edge-modified tools at site 30 (BLM).

Tool Type	Surface	Level 1	Level 2	Level 3	Level 4	Level 5	Level 6
Burins	2	1		1	1		
Burins (three-faced)		2					
Edge-modified flakes	4	5	1		1		2

75 degrees, none of the edges was steep enough to technically classify the tool as a scraper. Edge-modified tools made up 6.4 percent of the full sample assemblage.

A piece of basalt with edge modification and possible use wear was also recovered

(Figure 11). The unusual piece is 8.9 cm in length, 3.9 cm wide, 1.2 cm thick, and

weighs 57.25 g. It was found in the lowest level, 50-60 cm, of Test Pit 2.



Figure 11. A large, edge-modified, basalt tool from Test Pit 2, Level 6.

<u>Debitage</u>

The assemblage sample was composed of 244 flakes and 55 pieces of shatter (including flakes and shatter that were made into, or used as, tools). Of the flakes, 49 (20.1 percent) were complete, 67 (27.5 percent) were distal fragments, 42 (17.2 percent) were proximal fragments, and the remainder were other fragments. The size and weight data for complete flakes is presented in Table 25. The average length was 2.06 cm and the average weight was 3.34 g. When looking at complete flake sizes from the point of view of flake size categories, the size ranges with the highest number of flakes were the ranges of 15-20 mm and 30-40 mm, each consisting of 10 flakes, or 20.4 percent each of

Table 25. Size and weight summaries of complete flakes in the sample assemblage from site AZ:A:12:30 (BLM).

Complete Flakes (n-40)	Length	Width	Thickness	Weight
Complete Flakes (II=49)	(cm)	(cm)	(cm)	(g)
Average	2.06	1.8	0.53	3.34
Range	0.6 - 4.6	0.3 - 4.4	0.1 - 1.5	0.01 - 22.86

the complete flakes. The third highest number was in the 10-15 mm range, having 9 flakes, or 18.4 percent. Four complete flakes out of 49 (8.2 percent) had greater than 25 percent cortex. Flakes and shatter were primarily of the medium grade, Category 3 chert (Table 26). Two of the Category 2 flakes were made of red petrified wood (as identified by USGS geologist George Billingsley). The flakes made up 77.7 percent of the assemblage sample, and shatter constituted 17.5 percent.

Table 26. Numbers and percentages (in parentheses) of flakes and shatter in each raw material texture category for site AZ:A:12:30 (BLM).

	Category 1	Category 2	Category 3	Category 4	Category 5
Flakes	2 (0.8)	19 (7.8)	156 (63.9)	51 (20.9)	16 (6.6)
Shatter	0	3 (5.5)	38 (69.1)	13 (23.6)	1 (1.8)

Platform attributes were recorded for 113 platforms on complete and incomplete flakes from the site. Of these, 78 platforms (69.0 percent) were categorized as simple platforms, 21 (18.6 percent) were complex platforms, three (9.0 percent) of the platforms were cortex, and the remainder were indeterminate. Grinding was present on 17 (15.1 percent) of the platforms, was not present on 78 (69.0 percent), and could not be determined on 18 (15.9 percent). Of the 113 platforms, 5 (4.4 percent) were identified as having lips, 101 (89.4 percent) lacked lipping, and seven (6.2 percent) were indeterminate.

Use Wear

Twenty-seven artifacts, including one piece of shatter, had edge damage which may have been the result of utilization as a tool. Twelve were recovered from surface contexts and 15 from subsurface layers. Of these, 15 (55.6 percent) had one utilized edge, 9 (33.3 percent) had two edges utilized, two artifacts (7.4 percent) had three utilized edges, and one (1.7 percent) had four utilized edges. Seven (25.9 percent) of the utilized flakes were complete. With regard to texture, one obsidian tool (3.7 percent) was of Category 1 material, four tools (14.8 percent) were of Category 2 chert, 17 (63.0 percent) were of Category 3 chert, four (14.8 percent) of Category 4 chert, and one (3.7 percent) was of Category 5 chert. Utilized tools made up 8.6 percent of the sample assemblage.

Raw Material and Tools

The medium-grade, Category 3 chert was the most commonly used material for tool classes. Nine of ten bifaces, both projectile points, the single core, the six burins, the drill, eight of 13 edge-modified flakes, and 17 of 27 utilized artifacts were of this material group. One utilized flake in the analyzed assemblage was of obsidian, a Category 1

material. The remaining biface, two edge-modified flakes, and four utilized flakes were of the fine, Category 2 chert. Two edge-modified flakes and four utilized flakes were of Category 4 toolstone, and one edge-modified flake and one utilized flake were of the Category 5 material.

<u>Summary</u>

Evidence related to lithic production at site AZ:A:12:30 (BLM) appears relatively balanced between early and late stage materials. Some early stage activity is suggested by the 9 percent of platforms being of cortex and 8.2 percent of complete flakes having greater than 25 percent cortex. Complete flake sizes are distributed across several size ranges with a slight trend toward smaller flakes, but low percentages of complex platforms and lipping de-emphasize late-stage production work. As is the case with the other sites, there is little evidence to indicate that the earliest stages of reduction activity occurred here to much extent, given the presence of only one core and few cortical flakes. The latest stages of work, such as biface reduction and tool retouch, maintenance, and recycling also seems limited.

As pertains to other site activities, utilized flakes are scattered about the site, particularly in the test pit levels. In addition, nine more bifaces (including a drill), two projectile points, one core, five possible burins, and 13 retouched flakes were also found, which show a variety of tasks took place. Three tools, all from 0-10 cm of the two test pits, had three faces. This is unlikely to be a coincidence. One or more people who lived fairly contemporaneously here used a tool with a design that was not commonly used by others in the area. Seven tools from the site had edges that were crushed or ground, which suggests they were hand-held and used for more than just a brief task. Proximal

ends of two bifaces may indicate the rehafting of equipment at the site, and a possible projectile point tip may could have been embedded in hunted game.

With regard to how intensively raw materials were used, the number of functional units per tool (both edge modified and utilized) at 30 (BLM) ranged from one to five. A total of 42.3 percent (22) of the artifacts included in this group had only a single tool per artifact, followed by 34.6 percent having two, 11.5 percent having three, 9.6 percent with four, and 1.9 percent (one tool) having five functional units. Also at this site, 32.5 percent of the complete flakes that could have been used as tools did not show evidence of utilization. Only one of these 23 unused flakes was of Category 2 material, which may suggest that the finest-grained chert was used more intensively, although there was no association between the number of functional units and the tool material category. Low numbers of late-stage debitage and the higher number of informal tools (15 percent) to formal tools (4.1 percent) reflects little conservation of raw materials in general.

As to exotic toolstone, a total of five obsidian artifacts were sourced from the site: four late-stage flakes and one early-stage flake with a small amount of cortex on it. The flake with cortex had a maximum dimension of 1.8 cm. All of the samples were sourced to the Partridge Creek (Round Mountain), AZ area. The inhabitants of this site may have had regular contact with people in Arizona or perhaps had some other reason to favor this source. The flake stages of the obsidian indicate at least one small, partially-reduced core and rough performs were brought into the site, and the production of obsidian biface tools did occur.

AZ:A:12:71 (ASM)

This site is approximately five miles west of Mt. Trumbull and consists of a number of discrete, and probably unrelated, divisions: a dispersed lithic scatter below a group of collapsed structures on a ridge, and several separate groups of collapsed structures about 150 m east of the scatter and ridge, many of which have been disturbed by recent activities evident from modern hearths and cans dated to the 1960s. A few brown ceramics with unsorted olivine temper were described on the original site form, as well as lithics dominated by red chert. During the Mt. Trumbull field school several damaged slab-lined storage cists or rooms were discovered near the road. A single carbon sample from a test pit returned a date of A.D. 880-1010 (Buck 2006). A total of 5.8 percent (29 of 503 sherds) of the pottery recovered from the site was corrugated, and most of the pottery collected was gray ware. No painted sherds were recorded. The predominance of plain ware ceramics and the slab-lined structures suggest to Buck an occupation during the Basketmaker III period for at least part of the site. Over 150 lithics were collected from 392 square meters of surface units and four test pits.

The number of lithic artifacts available did not reach the preferred sample size for this site. They were recovered from SCUs A1, 2, 4, 5, 6, 7, 8, 9, and 10, Units B1, 2, and 3 (no lithic artifacts were recovered from unit A3) and Test Pits 1 through 4. Of a total of 155 lithic items, 112 (72.3 percent) were collected from the SCUs. From the test pits, 17 (11.0 percent) were from the surface, 23 (14.8 percent) were from 0-10 cm, two (1.3 percent) from 10-20 cm, and one (0.6 percent) from 20-30 cm. The sample assemblage contained 125 flakes, 21 pieces of shatter, and 15 tools: two biface fragments, one

projectile point, three cores, one denticulate, two possible burins, six retouched flakes, and 20 artifacts with possible use wear.

Bifaces

One possible projectile point, missing its tip, was recovered from the analyzed sample. It has two basal notches similar to a Parowan point base, but it is thick (0.5 cm) in relation to its width (1.4 cm), and may therefore have been designed for use as a hafted drill. The artifact is from the 0-10 cm level of Test Pit 2 and is of Category 3 chert (Figure 12). If the point/drill base is of a Parowan type, it can be narrowed to the time range of about A.D. 950 to A.D. 1150, which intersects the carbon date range retrieved from the charcoal sample. The point/drill made up 0.6 percent of the assemblage sample.



Figure 12. A projectile point and/or possible drill from AZ:A:12:71 (ASM).

Two other Stage II biface fragments were recorded in the analysis, both made of Category 3 chert. One was from the surface of Test Pit 3, and the other was from the 0-10 cm level of the same pit. The two biface fragments made up 1.3 percent of the assemblage sample.

Cores

Three multidirectional cores were recorded in the sample (Table 27). The core fragment from the surface of Test Pit 1 was primarily of Category 3 chert, also having some Category 4 chert. The small core from Test Pit 4 exhibited damage along one edge that could have been the result of using it as a tool. The cores made up 1.9 percent of the sample assemblage. In addition, a Category 2 chert cobble with a single flake removal was also collected from SCU A7. Its maximum dimension was between 1.5 and 2.0 cm.

Table 27. Attributes of cores recovered from AZ:A:12:71 (ASM) in order of unit and depth.

		Texture							
Unit ¹	Depth ²	Category	Type ³	Prep ⁴	#Neg Sc ⁵	#Plat ⁶	MaxDim ⁷	Weight (g)	Portion ⁸
SCUA7	S	3	MUL	UN	4	0	1.8	1.88	COM
TP1	S	3	MUL	UN	3	1	3.6	18.31	FRAG
TP4	L1	3	MUL	UN	6	1	2.1	2.38	COM

¹SCU=surface collection unit; TP=test pit.

² S=surface; L=level.

³ IND=indeterminate; MUL=multidirectional; UNI=unidirectional.

⁴ Prep=preparation type; PP=partially prepared; UN=unprepared.

⁵ Number of recognizable negative flake scars.

⁶ Number of recognizable platforms.

⁷ Maximum dimension (cm).

⁸COM=complete; FRAG=fragment; IND=indeterminate.

Edge-modified Tools

A total of nine edge-modified tools were recorded in the lithics sample (Table 28).

The first of two burins, the distal fragment of a Category 3 chert flake having one

modified edge, was recovered from SCU A4. A second burin, from the 0-10 cm level of

Test Pit 3, was on the proximal fragment of a Category 2 chert flake, which had one

modified edge and two edges with possible use wear damage. The flake's dorsal side

was covered with cortex. A medial fragment of a Category 3 chert flake from the surface of Test Pit 4 appeared to have a denticulated edge. Six other flakes had one or two modified edges. One of these was backed on the edge opposite from the modification. Three of these also had one edge that seemed to have use wear, and one flake had three edges with use wear. One of the six tools was complete, while three were distal fragments and two were proximal fragments. Four were of Category 3 chert and two were of Category 4 chert. Edge-modified tools made up 5.8 percent of the sample assemblage.

Table 28. Edge-modified tools at site AZ:A:12:71 (ASM).

Tool Type	Surface	Level 1	Level 2	Level 3
Burins	1	1		
Denticulate	1			
Edge-modified flakes	6			

<u>Debitage</u>

The assemblage sample included 125 flakes and 21 pieces of shatter (these numbers include flakes and shatter that were made into or used as tools but still retained recognizable flake or shatter properties). Of the flakes, 19 (15.2 percent) were complete, 39 (31.2 percent) were distal fragments, 33 (26.4 percent) were proximal fragments, and the remainder were other fragments. The average length of complete flakes was 2.0 cm, and the average weight was 2.68 g (Table 29). When looking at complete flake size categories, the size ranges with the highest number of flakes were the ranges of 15-20 mm with six flakes (31.6 percent), 25-30 mm with four flakes (21.1 percent), and 20-25

Complete Flakes (n-19)	Length	Width	Thickness	Weight
Complete T lakes (II=19)	(cm)	(cm)	(cm)	(g)
Average	2.0	1.9	0.58	2.68
Range	0.7 - 4.8	0.8 - 3.2	0.1 - 1.4	0.05 - 12.23

Table 29. Size and weight summaries of complete flakes in the sample assemblage from site AZ:A:12:71 (ASM).

mm and 30-40 mm each having three flakes or 15.8 percent each of the complete flakes. Seven complete flakes (36.8 percent) had greater than 25 percent cortex. Table 30 shows the flake and shatter raw material categories. One of the Category 5 flakes was basalt and three were quartzite. The flakes made up 80.6 percent of the assemblage sample, and shatter constituted 13.6 percent.

Table 30. Numbers and percentages (in parentheses) of flakes and shatter in each raw material texture category for site AZ:A:12:71 (ASM).

	Category 1	Category 2	Category 3	Category 4	Category 5
Flakes	0	8 (6.4)	84 (67.2)	21 (16.8)	12 (9.6)
Shatter	0	1 (4.8)	15 (71.4)	4 (19.0)	1 (4.8)

Platform attributes were recorded for 66 platforms on complete and incomplete flakes from the site. Of these, 41 platforms (62.1 percent) were categorized as simple platforms, 16 (24.2 percent) were complex platforms, eight (12.1 percent) of the platforms were cortex, and one (1.6 percent) was indeterminate. Grinding was present on 11 (16.7 percent) of the platforms, was not present on 41 (62.1 percent), and could not be determined on 14 (21.2 percent). Of the 66 platforms, four (6.1 percent) were identified as having lips, and 62 (93.9 percent) did not.

<u>Use Wear</u>

Twenty artifacts, including three pieces of shatter and one core, had edge damage which may have been the result of utilization as a tool. Out of the twenty, 16 (80.0 percent) had one utilized edge, including the three pieces of shatter and the core, and four (20.0 percent) had two edges utilized. Two (10.0 percent) of the utilized flakes were complete. Sixteen were recovered from surface contexts and four from subsurface layers. With regard to texture, three tools (15.0 percent) were of Category 2 chert, 15 (75.0 percent) were of Category 3 chert, one was (5.0 percent) of Category 4 chert, and one (5.0 percent) was of Category 5 chert. Utilized flakes made up 12.9 percent of the sample assemblage.

Raw Material and Tools

The medium-grade, Category 3 chert was the most commonly used material for tool classes. Both bifaces, the projectile point, one burin, the denticulate, four other edge-modified flakes, the three cores, and 14 utilized artifacts were in this raw material category. One burin and three utilized artifacts were of the finer-grained Category 2 chert. Two edge-modified flakes and a piece of utilized shatter were of the courser, Category 4 chert, and one utilized flake was of the Category 5 material.

Summary

Site AZ:A:12:71 (ASM) appears to have had primarily early to mid-stage lithic production activity. The platform characteristics and high percentage of flakes with cortex (in comparison to the other sites) point to early stage activity, but mid-stage production is indicated by the concentration of flakes in the middle-size groups. The

predominance of early-stage indicators imply there was little biface reduction and tool retouch, maintenance, and recycling taking place here.

In reference to other activities, utilized flakes were distributed among the collection units. In addition, there were two biface fragments, one drill, three cores, one denticulate, two possible burins, and six retouched flakes, representing a variety of activities having occurred at the site. Some unusual toolstone found in SCU A9 may have been either imported or transported by someone who had an opportunity to acquire material from outside the commonly used procurement area.

In relation to how intensively tools were used, the number of functional units on any non-bifacial tool at 71 (ASM) ranged from one to five, although no functional unit counts from this assemblage fell into the "four" category. Greater than half of the artifacts included in this calculation (65.5 percent) had only a single functional unit per artifact. The finer-grained chert material did not have more functional units that the other textures. Seventy-five percent of the analyzed complete flakes that could have been used as tools (i.e., were larger than the smallest complete tool size) did not show evidence of use. None of the complete tools or flakes was of the fine-grained, Category 2 chert, and there was no other evidence that unused flakes were associated with material type. The low numbers of late-stage debitage, the presence of amorphous cores, and the high percentage of informal (18.7 percent), compared to formal tools (1.9 percent), also suggest raw material was not used intensively. No obsidian was recovered from the site.

Comparison of Results by Attribute

In order to compare the six sites to each other, the analysis results are presented here by attribute. Within the following tables, where applicable, the fields with the highest or lowest measurements are highlighted in red to help identify patterns in the data.

Provenience

Artifacts from surface collection units make up 55.4 percent of the complete assemblage

(Table 31). Including artifacts that were on the surface of test pits, the total percentage of

surface artifacts is 62.7. By site, AZ:A:12:30(BLM) had the highest percentage of

subsurface artifacts with 47.8, followed by AZ:A:12:136(ASM) with 45.2,

AZ:A:12:204(BLM) with 44.6, AZ:A:12:14(MNA) with 34.0, AZ:A:12:214(ASM) with

22.6, and AZ:A:12:71(ASM) with 17 percent. With the exception of

AZ:A:12:136(ASM), most subsurface artifacts were recovered from Level 1 (0-10 cm).

				Depth	ı (cm)				
	TP Surf	0-10	10-20	20-30	30-40	40-50	50-60	SCU Surf	
Site	n	n	n	n	n	n	n	n	
	(%)	(%)	(%)	(%)	(%)	(%)	(%)	(%)	Total
AZ:A12:136(ASM)	19	33	62	31	30	26	0	193	304
	(4.8)	(8.4)	(15.7)	(7.9)	(7.6)	(6.6)	0	(49.0)	394
A 7. A 10.14(MINIA)	43	89	34	18	5	0	0	241	420
AZ:A12:14(MNA)	(10.0)	(20.7)	(7.9)	(4.2)	(1.2)	0	0	(56.0)	430
	3	16	8	5	0	0	0	33	65
AZ:A12:204(DLWI)	(4.6)	(24.6)	(12.3)	(7.7)	0	0	0	(50.8)	05
A 7. A 12.214(ACM)	17	36	5	0	0	0	0	123	101
AZ:A12:214(ASM)	(9.4)	(19.8)	(2.8)	0	0	0	0	(68.0)	181
A7. A 12.20/DL M	13	48	27	10	16	23	26	151	214
AZ:A12:30(BLM)	(4.1)	(15.3)	(8.7)	(3.2)	(5.1)	(7.3)	(8.2)	(48.1)	514
A 7. A 10.71 (A CM)	17	23	2	1	0	0	0	110	152
AZ:A12:71(ASM)	(11.1)	(15.0)	(1.3)	(0.7)	0	0	0	(71.9)	155
T (1	112	245	138	65	51	49	26	851	1527
1 otal	(7.3)	(15.9)	(9.0)	(4.2)	(3.3)	(3.2)	(1.7)	(55.4)	1537

Table 31. Counts and percentages of artifacts by depth.

Raw Material Type

The raw material types found at the Mt. Trumbull sites are summarized in Table 32. Over 98 percent of the material is chert, including the jasper and petrified wood (George Billingsley, personal communication). Basalt, obsidian and quartzite make up less than 1 percent each.

Table 32. Counts of raw material type by site.

Site	BST	CHT	JSP	OBS	QZT	RPW	Total
AZ:A12:136(ASM)	2	381	1	1	7	2	394
AZ:A12:14(MNA)	1	428				1	430
AZ:A12:204(BLM)	2	63					65
AZ:A12:214(ASM)	1	179			1		181
AZ:A12:30(BLM)	1	308	1	2		2	314
AZ:A12:71(ASM)	1	146			5	1	153
Total	8	1505	2	3	14	6	1537
Percentage	<1%	98%	<1%	<1%	<1%	<1%	

BST – Basalt; CHT – Chert; JSP – Jasper; OBS – Obsidian; QZT – Quartzite; RPW – Red petrified wood.

Raw Material Texture

Each artifact was placed into a texture category. Category 3 had the highest percentage of artifacts in all of the assemblages, with an overall 60 percent. Obsidian, or Category 1 items, made up less than 1 percent of any assemblage, if it was encountered at all. The glossiest cherts, Category 2, made up an average of 10 percent of the assemblages. Category 4 cherts were the most common after category 3 for all but all sites by AZ:A:12:14(MNA), having an average across assemblages of 23 percent. The coursest cherts, as well as small numbers of basalts and quartzites, classified as Category 5, made up an average of 6 percent of the site assemblages. Table 33 shows the number of artifacts classified into each texture category per site assemblage sample.

		Tex	xture Catego	ries		
	1	2	3	4	5	Total
Site	n (%)	n (%)	n (%)	n (%)	n (%)	Total
AZ:A:12:136(ASM)	1 (<1)	27 (7)	215 (55)	127 (32)	24 (6)	394
AZ:A:12:14(MNA)		77 (18)	280 (65)	68 (16)	5 (1)	430
AZ:A:12:204(BLM)		3 (5)	46 (70)	13 (20)	3 (5)	65
AZ:A:12:214(ASM)	1 (<1)	19 (10)	70 (39)	59 (33)	32 (18)	181
AZ:A:12:30(BLM)	2 (<1)	23 (7)	207 (66)	64 (20)	18 (6)	314
AZ:A:12:71(ASM)		11 (7)	104 (68)	25 (16)	13 (9)	153
Total	4 (<1)	160 (10)	922 (60)	356 (23)	95 (6)	1537

Table 33. Counts and percentages of artifacts by texture categories.

Tool Types

Artifacts having edge-modification were classified into tool types, the counts of which are summarized in Table 34. Site AZ:A:12:204(BLM) has the highest percentage of tools; however, these seems suspect given the low number of artifacts in the sample assemblage, only 65. Site AZ:A:12:14(MNA) has the lowest number of tools, but it is

Table 34. Counts of tool types by site.

]	Biface	S			Oth	ner Too	ols			
Site	BIF	PJP	DRL	BUR	COR	DEN	EMF	EMS	SCR	UNI	Total Tools
											n (%)*
AZ:A:12:136(ASM)	5	8		4	6		5	1	3	2	35 (8.8)
AZ:A:12:14(MNA)	13	2			4		6		1		26 (6.0)
AZ:A:12:204(BLM)	5	2		1	1		1		1		11 (16.9)
AZ:A:12:214(ASM)	2	3	1		2		2		1		11 (6.1)
AZ:A:12:30(BLM)	10	2	1	5	1		13				32 (10.2)
AZ:A:12:71(ASM)	2	1		2	3	1	6				15 (9.8)
Total Tools	37	18	2	12	17	1	33	1	6	2	130
* The total tools per	rcenta	ige rej	presen	ts the	perce	nt of t	he ent	ire ana	alyzec	l site	assemblage.
BIF - biface]	DRL -	drill				PJP -	proje	ectile	point
BUR - burin]	EMF -	edge	-modi	fied fl	ake	SCR	- scra	per	
COR - core]	EMS - edge-modified UNI - uniface								
DEN - denticulate		S	shatter								

also the site that has been frequently visited by members of the public, some of whom may have picked up tools. A low percentage of tools was also recovered from site AZ:A:12:214(ASM). Two of the burins at site AZ:A:12:30(BLM) were unusually shaped, having three faces. They were both recovered from the 0-10 cm level in the same test pit. Another burin from the same site exhibited polish on one of its edges.

Complete Flake Size

Each complete flake was placed into a size range according to its maximum dimension. Table 35 represents counts of flakes within a 10mm range, with the exception of the largest range which spans 20mm. Using these ranges, most sites have the maximum number of flakes in the 10-20mm range. Site AZ:A:12:204(BLM) has more larger flakes than the others, with 44.4 percent being in the 30-40mm range. When using a 5mm range scale, differences among the sites with regard to small flakes become more visible. Within these ranges, site AZ:A:12:14(MNA) has the greatest percentage of smallest flakes, with 28.3 percent falling into the 10-15mm size range.

	0-10	10-20	20-30	30-40	40-50	50-60	60-80		% of	
	mm	mm	mm	mm	mm	mm	mm	Total	Site	
Site	n (%)	n (%)	n (%)		Assem.					
A7. A. 12. 12(A CM)	6	27	20	14	5	2	3	77	10.5	
AZ.A.12.130(ASIVI)	(7.8)	(35.1)	(26.0)	(18.2)	(6.5)	(2.6)	(3.8)	//	19.5	
$\Lambda 7 \cdot \Lambda \cdot 12 \cdot 14 (MNIA)$	6	30	18	2	2	1	1	60	14.0	
AZ:A:12:14(MINA)	(10.0)	(50.0)	(30.0)	(3.3)	(3.3)	(1.7)	(1.7)	00	14.0	
A7. A. 12.204(DI M)	1	2	2	4				0	12.8	
AZ.A.12.204(DLIVI)	(11.1)	(22.2)	(22.2)	(44.4)	-	-	-	9	15.8	
$\Delta 7 \cdot \Delta \cdot 12 \cdot 214 (\Delta SM)$	_	6	9	5	3	2	_	25	13.8	
AL.A.12.214(ASIVI)	_	(24.0)	(36.0)	(20.0)	(12.0)	(8.0)	_	23	15.0	
A7.A.12.30(BLM)	4	19	11	10	4	1		40	15.6	
AZ:A:12:30(BLM)	(8.2)	(38.8)	(22.4)	(20.4)	(8.2)	(2.0)	-	49	15.0	
A 7. A . 12.71 (A CNA)	1	7	7	3	1			10	12.4	
AL.A.12.71(ASIVI)	(5.3)	(36.8)	(36.8)	(15.8)	(5.3)	-	-	19	12.4	

Table 35. Counts and percentages of complete flakes falling within each size range.

Complete Flake Average Size and Weight

The length, width, and thickness in centimeters, as well as the weight in grams, was measured for each complete flake (Table 36). Site AZ:A:12:14(MNA) had the smallest average flake size and weight among the sites, and AZ:A:12:214(ASM) had the largest.

Site	Avg Length (cm)	Avg Width (cm)	Avg Thickness (cm)	Avg Weight (g)	Number of Complete Flakes
AZ:A:12:136(ASM)	2.22	2.11	0.58	5.18	77
AZ:A:12:14(MNA)	1.75	1.60	0.43	*7.85/1.84	60
AZ:A:12:204(BLM)	2.34	2.06	0.50	3.17	9
AZ:A:12:214(ASM)	2.56	2.46	0.67	5.31	25
AZ:A:12:30(BLM)	2.06	1.84	0.53	3.34	49
AZ:A:12:71(ASM)	1.98	1.94	0.58	2.68	19

Table 36. Average size and weight of complete flakes for each site.

* An unusually large flake skewed the weight average for site AZ:A:12:14(MNA). The weight 1.84 g represents the calculation without the outlier.

Edge Modification and Use Wear

Edge modification and use wear were recorded for all sites. Table 37 shows the

number of artifacts having edge modification, broken down into how many edges were

Tuble 57. Counts of artifacts having one of more edge mounted margins for each site.									
Site	1 Edge	2 Edges	3 Edges	Total Modified Artifacts	% of Analyzed Assemblage				
AZ:A:12:136(ASM)	8	7	-	15	3.7				
AZ:A:12:14(MNA)	5	2	-	7	1.6				
AZ:A:12:204(BLM)	1	4	-	5	7.6				
AZ:A:12:214(ASM)	2	1	-	3	1.7				
AZ:A:12:30(BLM)	17	5	2	24	7.6				
AZ:A:12:71(ASM)	6	3	-	9	5.8				
Total	39	22	2	63					

Table 37. Counts of artifacts having one or more edge-modified margins for each site.

modified, and Table 38 presents the same information for utilized artifacts. The numbers in these two tables include flakes, cores, and shatter. Where a functional tool unit (edge) may have had damage due to both modification and use, the unit was counted in the edge-modified category.

Site	1	2	3	4	Total Utilized	% of Analyzed		
Sile	Edge	Edges	Edges	Edges	Artifacts	Assemblage		
AZ:A:12:136(ASM)	35	13	4		52	13.1		
AZ:A:12:14(MNA)	38	17	7	1	63	14.7		
AZ:A:12:204(BLM)	7	3	3		13	20.0		
AZ:A:12:214(ASM)	18	5	1	1	25	13.8		
AZ:A:12:30(BLM)	20	16	4	1	41	13.1		
AZ:A:12:71(ASM)	19	5	1		25	16.1		
Total	137	59	20	3	219			

Table 38. Counts of artifacts having one or more utilized margins for each site.

Cortex

The amount of cortex on the dorsal face (greater or less than 25 percent) was recorded for all complete flakes (Table 39). Site AZ:A:12:14(MNA) had the lowest percentage of complete flakes (5.0 percent), and AZ:A:12:71(ASM) had the highest (36.8 percent).

Site	# of Complete Flakes	# Complete Flakes In Assemblage	% of Complete Flakes
AZ:A:12:136(ASM)	8	77	10.4
AZ:A:12:14(MNA)	3	60	5.0
AZ:A:12:204(BLM)	1	9	11.1
AZ:A:12:214(ASM)	5	25	20.0
AZ:A:12:30(BLM)	4	49	8.2
AZ:A:12:71(ASM)	7	19	36.8
Total	28	239	11.7

Table 39. Counts and percentages of complete flakes having 25 percent or greater cortex on the dorsal face.

Platform Attributes

Platform type was recorded for 529 flaked lithic artifacts (Table 40). The indeterminate category includes platforms that may have been too crushed to identify the platform type or for which the rough texture of the material made it difficult to identify the presence or absence of facets. The numbers of simple platforms were higher than complex platforms, although to a lesser degree for site AZ:A:12:14(MNA), which only had an 8.3 percent difference between the percentages of simple and complex platforms. The highest percentage of simple platforms was recorded for site AZ:A:12:204(BLM) with 72.4 percent , and the lowest percentage was present at site AZ:A:12:14(MNA), having 49.6 percent.

		Platform Type							
	Simple	Complex	Cortex	Indeterminate					
Site	n (%)	n (%)	n (%)	n (%)	Total #				
AZ:A:12:136(ASM)	86 (63.2)	36 (26.5)	10 (7.4)	4 (2.9)	136				
AZ:A:12:14(MNA)	60 (49.6)	50 (41.3)	3 (2.5)	8 (6.6)	121				
AZ:A:12:204(BLM)	21 (72.4)	5 (17.2)	3 (10.4)	-	29				
AZ:A:12:214(ASM)	44 (67.7)	16 (24.6)	2 (3.1)	3 (4.6)	65				
AZ:A:12:30(BLM)	78 (69.0)	21 (18.6)	9 (8.0)	5 (4.4)	113				
AZ:A:12:71(ASM)	41 (63.1)	15 (23.1)	8 (12.3)	1 (1.5)	65				
Total	330	143	35	21	529				

Table 40. Counts and percentages of platform types for each site.

For each artifact with a platform, the presence or absence of platform preparation, in the form of grinding, and the presence or absence of a lip on the ventral side of the platform was recorded (Table 41). Most platforms lacked grinding, however site AZ:A:12:14(MNA) had the highest percentage (19.8), and AZ:A:12:214(ASM) had the lowest (9.2 percent). With regard to lipping, AZ:A:12:204(BLM) had the highest

percentage (20.7), and sites AZ:A:12:136(ASM) and 30(BLM) both had the lowest percentages of 4.4.

		0 1		00				
	Prese	ence of Pla	tform	Prese	Total #			
		Grinding			Lipping			
		n (%)			n (%)		Diatforma	
Site	Yes	No	Ind	Yes	No	Ind	Flationis	
A7.A.12.126(ASM)	24	93	19	6	128	2	126	
AZ:A:12:150(ASM)	(17.6)	(68.4)	(14.0)	(4.4)	(94.1)	(1.5)	150	
A7.A.12.14(MNIA)	24	77	20	23	90	8	101	
AZ:A:12:14(MINA)	(19.8)	(63.6)	(16.5)	(19.0)	(74.4)	(6.6)	121	
A7.A.12.204/DIM	5	21	3	6	23		20	
AZ.A.12.204(DLWI)	(17.2)	(72.4)	(10.4)	(20.7)	(79.3)	-	29	
A7.A.12.214(ASM)	6	54	5	4	57	4	65	
AL.A.12.214(A5W)	(9.2)	(83.1)	(7.7)	(6.2)	(87.6)	(6.2)	05	
A7.A.12.20(PLM)	17	78	18	5	101	7	112	
AZ:A:12:50(BLM)	(15.0)	(69.0)	(16.0)	(4.4)	(89.4)	(6.2)	115	
A7.A.12.71(ASM)	11	40	14	4	61		65	
AL.A.12.71(ASM)	(16.9)	(61.5)	(21.6)	(6.2)	(93.8)	-	05	
Total	87	363	79	48	460	21	529	

Table 41. Counts and percentages of platforms having grinding or lipping.

Biface Stage

Biface stage was recorded for 28 artifacts in the Mt. Trumbull assemblages (Table 42). These counts do not include projectile points. Bifaces made up the following percentages of each assemblage: AZ:A:12:136(ASM) 0.5 percent, AZ:A:12:14(MNA)

Site	Stage 1	Stage 2	Stage 3	Stage 4	Total
AZ:A12:136(ASM)		2			2
AZ:A12:14(MNA)		3	4	4	11
AZ:A12:204(BLM)	1	1	2		4
AZ:A12:214(ASM)				2	2
AZ:A12:30(BLM)	1	1	2	3	7
AZ:A12:71(ASM)		2			2
Total	2	9	8	9	28

Table 42. Counts of biface stages by site.

2.5 percent, AZ:A:12:204(BLM) 6.1 percent, AZ:A:12:214(ASM) 1.1 percent,

AZ:A:12:30(BLM) 2.2 percent, and AZ:A:12:71(ASM) 1.3 percent.

Cores

A total of 17 cores were recovered from the six sites (Table 43). Of the cores for

which a type could be determined, all but two were multidirectional. Overall, cores were

evenly distributed between surface and subsurface contexts. Site AZ:A:12:136(ASM)

had six cores, which made up 1.5 percent of the assemblage. The counts and percentages

for the other sites were AZ:A:12:14(MNA): four cores (0.9 percent);

AZ:A:12:204(BLM): one core (1.5 percent); AZ:A:12:214(ASM): two cores (1.1

percent); AZ:A:12:30(BLM): one core (0.3 percent), and AZ:A:12:71(ASM): three cores

(1.9 percent).

Site	Unit	Depth	Texture	Type ¹	Prep ²	#NFS ³	# P ⁴	Max Dim (cm)	Wt (g)	Portion
AZ:A:12:136(ASM)	SCUA3	S	4	AC	UN	1	1	3.1	6.78	COM
AZ:A:12:136(ASM)	SCUA5	S	4	MUL	IND	4	IND	4.9	20.11	IND
AZ:A:12:136(ASM)	SCUB4	S	3	MUL	UN	16	5	3.8	35.23	COM
AZ:A:12:136(ASM)	TP1	L2	4	MUL	UN	11	5	6.9	84.68	COM
AZ:A:12:136(ASM)	TP1	L2	3	MUL	UN	5	2	3.1	11.12	FRG
AZ:A:12:136(ASM)	TP2	L2	3	UNI	IND	6	0	3.4	11.17	FRG
AZ:A:12:14(MNA)	SCU2	S	3	MUL	UN	7	1	3.5	12.71	COM
AZ:A:12:14(MNA)	SCU2	S	3	MUL	PP	8	1	5.1	55.63	COM
AZ:A:12:14(MNA)	TP1	L1	3	MUL	PP	7	6	5.1	42.88	COM
AZ:A:12:14(MNA)	TP2	L1	4	IND	UN	2	2	4.1	19.44	FRG
AZ:A:12:204(BLM)	SCUA4	S	3	MUL	UN	7	1	3.9	11.45	COM
AZ:A:12:214(ASM)	SCUB9	S	2	MUL	UN	4	3	4.2	17.47	COM
AZ:A:12:214(ASM)	TP5	L1	3	MUL	UN	3	2	3.6	17.15	FRG
AZ:A:12:30(BLM)	TP2	L2	3	MUL	UN	3	0	3.6	8.55	FRG
AZ:A:12:71(ASM)	SCUA7	S	3	MUL	UN	4	0	1.8	1.88	COM
AZ:A:12:71(ASM)	TP1	S	3	MUL	UN	3	1	3.6	18.31	FRG
AZ:A:12:71(ASM)	TP4	L1	3	MUL	UN	6	1	2.1	2.38	COM

Table 43. Attributes of cores found at the Mt. Trumbull sites.

 1 AC = Assayed Cobble, IND = Indeterminate, UNI = Unidirectional,

MUL = Multidirectional

² IND = Indeterminate, PP = Partially Prepared, UN = Unprepared

³ Number of Negative Flake Scars

⁴ Number of Platforms

Summary of the Flaked Stone Analysis Results

With the exception of the initial stage, the full range of tool production occurred at Mt. Trumbull. While formal tools are present, the need for them was not great, and they were perhaps made for offsite use. Some maintenance occurred, but sharp edges could easily be created by making a new flake from the plentiful raw material available in the area. The variety of tool types indicates several activities occurred and were generally similar across sites.

The inhabitants as Mt. Trumbull used cherts of various grain sizes to make their tools, and rarely any other type of toolstone. Category 3 chert was that most often used for tools. There is only a small amount of evidence the finer-grained Category 2 chert was conserved. The medium grained material appears to have adequately served the needs of the tool makers at these sites. The combined results of the analysis are discussed in the context of the research questions in Chapter 6.

CHAPTER 5

OBSIDIAN STUDY - METHODS AND RESULTS

This chapter describes the obsidian sourcing analysis conducted on artifacts from the Mt. Trumbull area. Information is presented on the locations from which the obsidian was collected, the trace element analyses, and results of the chemical sourcing, followed by a discussion of the results in the context of the Virgin Anasazi trade network.

Methods

Obsidian samples were acquired by two means. Slightly more than half came from three sites included in the lithics analyses reported in this paper and from other sites and loci visited during the Mt. Trumbull field schools. All of the Mt. Trumbull obsidian collected through the 2006 field season was sourced. The other samples are from sites and isolated loci between Mt. Trumbull and the Toroweap Valley and were borrowed from the Archaeological Repository at Southern Utah University. These collections were made in the 1970s during archaeological surveys in the Toroweap Valley and represent the closest collected sites to Mt. Trumbull. Table 44 lists the sites involved and indicates which were associated with the Mt. Trumbull project and which were recorded during the 1970s activities, as well as the types of artifacts. All of the samples are from an area approximately 13 miles square.

Site	BIF	BUR	DEB	DRL	EMF	PJP	UTF	TOTAL
AZ:A:12:136 (ASM)*			2				1	3
AZ:A:12:30 (BLM)*			2				3	5
AZ:A:12:214 (ASM)*				1			1	2
AZ:A:12:131 (BLM)*	1						3	4
AZ:A:12:52 (MNA)*			1				1	2
AZ:A:12:223 (ASM)*							1	1
BLM RD #5*						1		1
GC-663^	1	2			1	6	2	12
GC-689^	1							1
GC-754^						1		1
GC-777^							1	1
GC-781^			1				1	2
GC-787^							1	1
GC-908^						1		1
GC-946^						1		1
Random Find #1*†					1			1
Random Find #2^						1		1
T070806PB01*							1	1

Table 44. Collection locations and tool types for obsidian artifacts chemically sourced for this thesis.

BIF=biface; BUR=burin; DEB=debitage; DRL=drill; EMF=edge-modified flake; PJP=projectile point; UTF=utilized flake.

* Collected during the Mt. Trumbull field schools.

^ Borrowed from Southern Utah University.

† Random Find #1 was collected near site AZ:A:12:204 (BLM) and is referred to by that site number in Appendix 2.

The obsidian was sent to the Northwest Research Obsidian Studies Laboratory, where Craig Skinner conducted an X-ray fluorescence (XRF) analysis on each piece. Most geologic sources of obsidian are similar in their trace element composition, yet demonstrate adequate intersource variability such that individual sources can be distinguished. Each sample was nondestructively analyzed for a variety of trace element concentrations (Ti, Mn, Fe₂O₃^T, Zn, Ga, Rb, Sr, Y, Zr, Nb, and Ba). The tests were conducted using a Spectrace 5000 energy dispersive X-ray fluorescence spectrometer. The equipment requires specimens with a minimum diameter of no less than about 10 mm and a thickness of no less than 1.5 mm. The lab has designed a database management system which compares the results with a geologic source reference collection that identifies the obsidian source (Northwest Research Obsidian Studies Laboratory 2008). Once the source of an obsidian artifact is identified, it is possible in most cases to determine how far it had traveled from its place of origin. These results were used to address the research questions related to obsidian.

Results of Obsidian Chemical Sourcing

The obsidian sourcing results provide information on trade and other interactions between the inhabitants of Mt. Trumbull and their regional neighbors. What is known about Virgin Anasazi trade is discussed in Chapter 3, along with a brief introduction to current understanding of obsidian trade in the area and in nearby regions.

Forty-one pieces of obsidian collected during survey and site recording activities within 13 miles of Mt. Trumbull were analyzed by the Northwest Research Obsidian Studies Laboratory (Appendix B). Of these, 20 were collected during the Mt. Trumbull field schools, and 21 were borrowed from Southern Utah University (SUU) for the purpose of increasing the sample size of obsidian from the area. The Mt. Trumbull field school samples included five artifacts from AZ:A:12:30 (BLM), four from AZ:A:12:131 (BLM), three from AZ:A:12:136 (ASM), two each from AZ:A:12:52 (MNA) and AZ:A:12:214 (ASM), one each from AZ:A:12:223 (ASM) and T070306PB01, as well as two artifacts found in the study area that were not associated with particular sites. The samples from SUU included 12 artifacts from site GC-663, two from GC-781, one each

from GC-689, GC-754, GC-777, GC-787, GC-908, and GC-946, and one artifact found in the area that was not associated with a site.

X-ray fluorescence testing resulted in the identification of obsidian from sources in Utah, Arizona, and one piece from Nevada. Two pieces were from unidentified sources (Table 45). Sources in both Arizona and Utah are well represented, having 24 and 14 pieces, respectively. Although the sources in Arizona are generally closer to the project

Table 45. Results of XRF analysis on 41 samples of obsidian from the Mt. Trumbull area.

Obsidian Source	Number of Specimens
	from Source
Partridge Creek/Round Mountain (AZ)	15
Modena (UT)	12
Black Tank (AZ)	6
Government Mountain (AZ)	2
Wild Horse Canyon (UT)	2
Black Rock Area (UT)	1
Mt. Hicks (NV)	1
Unknown Type B	1
Unknown Type C	1

area than those in Utah, the Grand Canyon lies between the Arizona sources and Mt. Trumbull, which dramatically lengthens the paths that had to be traversed to acquire the material. George Billingsley, the creator of the USGS geographic map for the Mt. Trumbull area, has identified trails that cross the canyon to the east which are believed to have been used in prehistoric times due to the presence of flaked stone materials found along the paths (personal communication). One edge-modifed flake was found to be from the Mt. Hicks source, which is located over 300 miles to the northwest. Figure 13 shows the locations of the obsidian sources in relation to the project area, and details of the sourcing results are presented in Table 46. Descriptions of the sources are in Appendix 3.



Figure 13. Locations of obsidian sources. From Skinner 2006 (Appendix 2).

Obsidian and the Virgin Anasazi Interaction Network

Interaction between the Virgin Anasazi and their neighbors has been previously understood through the study of turquoise, shell, and pottery, and was described in Chapter 3. Briefly, turquoise is believed to have been traded or transported to other Virgin Anasazi habitations in the region from mines located near the present-day towns of Boulder City, Nevada; Baker, California; and Searchlight, Nevada. Virgin Anasazi

Table 46. Results of obsidian chemical sourcing.

Site	Source	No	Type*	Depth**	ST
	Government Mtn	1	UTF	S	AZ
AZ:A:12:136 (ASM)	Modena	1	DEB	S	UT
	Partridge Creek (Round Mtn)	1	DEB	Depth** S S TP2/L1 TP1/L5 (1) S TP1/L5 (1) S	AZ
AZ:A:12:30 (BLM)	Partridge Creek (Round Mtn)	5	UTF (3) DEB (2)	S (4) TP1/L5 (1)	AZ
A7.A.12.214 (ASM)	Black Tank	1	DRL	S	AZ
AZ.A.12.214 (ASIVI)	Partridge Creek (Round Mtn)	1	UTF	S	AZ
AZ:A12:131 (BLM)	Modena	3	UTF (2) BIF FRG	S	UT
	Partridge Creek (Round Mtn)	1	UTF	S	AZ
A7. A. 12.52 (MNIA)	Partridge Creek (Round Mtn)	1	DEB	S	AZ
AZ:A:12:52 (MINA)	Wild Horse Canyon	1	UTF	S	UT
AZ:A:12:223 (ASM)	Partridge Creek (Round Mtn)	1	UTF	S	AZ
BLM RD #5	Modena	1	PJP	S	UT
AZ:A:12:136 (ASM)AZ:A:12:30 (BLM)AZ:A:12:214 (ASM)AZ:A12:131 (BLM)AZ:A:12:52 (MNA)AZ:A:12:223 (ASM)BLM RD #5BLM RD #5GC-663GC-669GC-754GC-777GC-781GC-781GC-946GC-946Random Find #1 (Near AZ:1:12:204 (BLM)Random Find #2T070306PB01	Black Tank	4	PJP (2) UTF BUR/ UTF	S	AZ
	Modena	3	BIF BUR UTF	S	UT
	Partridge Creek (Round Mtn)	4	EMF PJP (3)	S	AZ
	Unknown Type C	1	PJP	S	-
GC-689	Partridge Creek (Round Mtn)	1	BIF	S	AZ
GC-754	Modena	1	PJP	S	UT
GC-777	Wild Horse Canyon	1	UTF	S	UT
GC-781	Modena	2	DEB UTF	S	UT
GC-787	Black Tank	1	UTF	S	AZ
GC-908	Unknown Type B	1	PJP	S	-
GC-946	Government Mtn	1	PJP	S	AZ
Random Find #1 (Near AZ:1:12:204 (BLM)	Mt. Hicks	1	EMF	S	NV
Random Find #2	Black Rock Area	1	PJP	S	AZ
T070306PB01	Modena	1	UTF	S	UT

Totals by state are: Utah 14, Arizona 24, Nevada 1, Unknown 2.

*Abbreviations: BIF=biface; BUR=burin; DEB=debitage; DRL=drill; EMF=edgemodified flake; FRG=fragment; PJP=projectile point; UTF=utilized flake.

**L=level; TP=test pit; S=surface.

people are thought to have mined at these locations due to the presence of Puebloan-type artifacts. Turquoise appears to have also been traded to populations to the north, south, east, and west of these mines, perhaps even as far as Chaco Canyon in northwest New Mexico. Shell from the coast of southern California and the Gulf of California has been recovered from Virgin Anasazi sites at Lost City. These items appear to have been crafted into beads and pendants prior to being transported into the area.

Small amounts of pottery exchange occurred between the Virgin Anasazi and groups east of Kanab Creek, and with the Fremont to the north. In larger quantities, ceramics were transported between the upland (Shivwits and Uinkaret Plateaus) and lowland (Moapa Valley) areas within the Virgin Anasazi region, and into the upper Las Vegas Valley. The movement of ceramics within the region has been tracked largely through the presence of olivine-tempered pottery (Moapa Gray Ware), which primarily originates in the Mt. Trumbull area and has been recovered from Moapa Valley sites.

Some individuals or households in the lowland areas owned Moapa Gray Ware, but others did not. In addition, the types of Moapa Gray Ware found in the Moapa Valley were less varied than those found in the Mt. Trumbull area, meaning that only some producers made pots that were transported to Moapa Valley. These data suggest personal relationships may have been the means through which lowland groups acquired ceramics (Allison 2000). Pottery could have been moved into Moapa Valley while friends and family visited each other in either direction. That is, a daughter who lived in Moapa Valley could have been given an olivine-tempered pot containing gifts or supplies while visiting her upland pottery-producing mother - a sort of prehistoric "care package."

items with her to the lowland area to trade with friends while her family group made a seasonal visit to collect lowland subsistence materials, an activity that could have lasted only a few days or as long as months. These are two of many types of scenarios that would explain the transportation of Mt. Trumbull ceramics into the lowland area. The obsidian chemical sourcing primarily indicates relationships between the Virgin Anasazi at Mt. Trumbull and groups south of the Grand Canyon and in southwestern Utah. Having the results of the obsidian analysis from the Mt. Trumbull area artifacts, we now see an increasingly complex pattern of contact between people in all directions (Figure 14). In Figure 14, the green arrow indicating movement of obsidian from south of the Grand Canyon arcs north prior to crossing the canyon on its eastern edge. This



Figure 14. Updated directions of known Virgin Anasazi contact with other groups based on the distribution of goods away from their sources. The red dot indicates the location of Mt. Trumbull.

represents information from USGS geologist George Billingsley (personal communication) that Native American trails exist along the canyon in the indicated area and were the most likely means of crossing on foot. The implications of the results of this obsidian analysis with regard to Virgin Anasazi trade in general are further discussed in Chapter 6.

Chapters 4 and 5 have presented the methods and results for the flaked stone analysis and the obsidian chemical sourcing. The following chapter summarizes these findings and applies them to the research questions.

CHAPTER 6

SYNTHESIS AND CONCLUSIONS

In order to learn about behavior at Mt. Trumbull related to flaked stone tools, I have applied the results of obsidian sourcing and flaked stone analysis. The research questions below assist in identifying the types of materials the Virgin Anasazi had access to, how they put them to use, and how they obtained toolstone that was not immediately available to them.

Research Questions

The following questions were designed to guide the research process. The lithic attributes used for the analysis were chosen because they have characteristics that can be related to behaviors addressed in the questions. The middle-range theories, experiments, and studies that make these behavioral interpretations possible were discussed in Chapter 2. Whereas behaviors were discussed for each site in Chapter 4, in this chapter the results are synthesized to answer questions about the six Mt. Trumbull sites as a whole.

1. What do the tools and debitage from the assemblages reveal about how people lived at Mt. Trumbull?

Identifying activity patterns based on lithic artifacts can be difficult. Despite the issues discussed below surrounding the recognition of activities at Mt. Trumbull, I have been able to examine the assemblages to infer simple behavioral patterns. Given the similarity between the types of sites and the difficulties in matching activity with tool

morphology, I have examined the numbers of tool types and related debris between sites to compare the variety of activity types, rather than the activities themselves.

Production Stages

From the lithic analysis we can infer some tool production patterns. With the exception of the initial stage, the full range of tool production appears to have taken place at the Mt. Trumbull sites. Much of the earliest core reduction may have occurred outside the sites, as cortical flakes are not especially abundant and cores are only present in small quantities. Given the high frequency of flakes, we would expect cores to be an important part of the site toolkits. The low numbers of cores at the sites could be related to how raw material was collected or quarried. Perhaps flakes were carried into the sites after removal from cores off site. This means that tool makers would have visited quarry locations, possibly as part of an embedded procurement system, and spent some time testing raw material cobbles or outcroppings. They would have been looking for stone that was relatively free of fractures and impurities, such that flakes could have been removed from cores in a predictable manner. By collecting flakes rather than cores, the load being carried back to the site would have been lighter, or there may have been more capacity to carry other items.

Formal vs. Informal Tools

While formal tools are present, there was apparently not a need to focus significant periods of time and energy making them, and those that are present were perhaps made for offsite use. To avoid carrying cores on outings such as hunting trips, bifaces may have been prepared ahead of time. Some retouch did occur at the sites, but sharp edges

could be manufactured by producing new flakes with very little effort, or flakes produced at quarries may have been cached and used as needed.

Late-stage production would be represented at sites by the small flakes resulting from finishing bifaces and the retouch, maintenance, and recycling of tools. Evidence for the latest stages of reduction is limited. This may be a function of the collection methods, natural formation processes, and other difficulties involved in recovering very small debitage. It may also be directly related to the low numbers of bifaces and edge-modified flakes. Where an available, unmodified flake could complete the task, there would have been little need to retouch a used flake. Conceivably, flakes were more likely to be modified when caches were running low and an outing to the quarry hadn't been made yet.

One site, AZ:A:12:14 (MNA), appears to have later-stage debitage on the average than do the other sites, especially in comparison to AZ:A:12:214 (ASM). This perhaps indicates that people occupying the site spent more time making bifaces and carrying out retouch and tool maintenance. On the other hand, it may also be the result of visitors or pothunters carrying large artifacts off the site, which would skew the flake size ratios. Site 14 (MNA) is the only site included in the analysis that is regularly accessed by the public, and a historic sawmill was once operated adjacent to the site.

Archaeologists interested in the upland Virgin Anasazi would benefit from conducting research on quarries in the area. Given the assemblages found at these six sites, nearby quarries would be expected to have large numbers of early stage debitage and cores. Some quarries have been identified by previous projects, but have not been recorded in much detail. At the time USGS geologist George Billingsley looked over a

sample of the materials being analyzed for this thesis, he specifically identified the Fossil Mountain Member of the Kaibab Formation (Lower Permian) as a source for these stone types. The unit is described as "cliffs of chert-banded limestone" which erode "into conical pillars along cliffs" on the east side of Toroweap Valley and in the upper Cove Canyon (Billingsley et al. 2001). I was able to locate numerous pebble to cobble-sized chert nodules in a large wash at the bottom of the upper Toroweap Valley below these cliffs. Smaller pebble-sized cherts can also be found on the slopes of Mt. Trumbull and the surrounding hills.

Broken Tools

Some base fragments of projectile points suggest Mt. Trumbull inhabitants rehafted their arrows at these camps, but in many cases the distal ends of hafted tools are present at the sites, which is somewhat curious. The more common articles on ethnographic research related to lithic tool production and use (Binford 1979; Gould et al. 1971) address the presence of proximal rather than distal ends of hafted tools. Broken tools in general have been associated with low raw material abundance (Bamforth 1986), but the Mt. Trumbull assemblage tends to reflect a high abundance of raw materials. Perhaps if further excavation occurred at the sites, more proximal tool fragments would be recovered.

Tool Type Varieties

The variety of tool types indicates a number of activities occurred and were generally similar across sites. Work was done with utilized flakes, burins, scrapers, edge-modified flakes, unifaces, and bifaces. Occasionally denticulates and drills were put to use, and at one site there was the need or preference for a three-faced burin-type tool. Polish was
also identified on a tool. The two tools with three faces were both found in the 0-10 cm level of the same test pit, which could indicate they were used during the same occupation period and in the same location. The site with the smallest sample size of only 65 artifacts, AZ:A:12:204 (BLM), had as many tool types as the sites with the largest samples, suggesting that although 204 (BLM) does not have above-ground architecture and may not have been occupied as long as some other sites, the activities that occurred there were similar in scope to sites with rock structures that were used more repeatedly or over longer occupation periods. This may indicate that the same types of activities were carried out at Mt. Trumbull habitation sites over much of the Basketmaker and Puebloan periods.

I have not tried to establish specific types of activity based on tool morphology or use wear characteristics. The interpretation of site activities based on lithic tools is complicated by the propensity for one tool to be used for several types of activities and the challenges involved in determining how a tool becomes damaged without using high magnification. A more detailed discussion on these problems occurs in Chapter 2.

In addition to the complexity of inferring activities by tool morphology, the nature of the Mt. Trumbull field work focuses primarily on large sites with architecture. Under these circumstances, tool morphology will be similar between sites, as they are likely to all be habitation sites. Therefore, the tool types are unlikely to reveal activities that would enable the identification of diverse site types such as quarries or short-term use camps that could have been used during hunting, agricultural, or other special-use activities.

2. Was higher quality chert used differently than other cherts?

The inhabitants as Mt. Trumbull used various qualities of cherts to make their tools, and rarely any other type of toolstone. Of the four grades of cherts categorized for this project (Categories 2 through 5), the medium grade, Category 3 chert was that most often used for tools, and there is only rare evidence that the finer-grade material was used differently at the sites, which is discussed below. Category 4 chert was also used frequently, but not to the same degree as Category 3. The reason the medium grade material was more often used could simply be related to the abundance of Category 3 chert in the area in comparison to Category 2 material. Another possibility is that although Category 2 chert would have provided a sharper edge, the Category 3 material may have provided a sharp enough edge for the task at hand, but would have needed to be sharpened less often than the finer, more brittle chert.

Although Category 3 chert was used more frequently for tools in general, it was note used more often for any particular tool type recognized within the scope of this analysis. Without high-magnification use wear analysis, it is impossible to determine if finergrained chert was used for different tasks than courser-grained cherts.

The true availability of Category 2 chert near Mt. Trumbull is unknown, since a highquality chert quarry has not yet been recorded. There is more Category 3 chert found in washes and eroding down hills in Toroweap Valley, but some finer chert is also present. Access to Category 2 material may have restricted either due to its low quantities or because of social or physical barriers to its sources; however, if restricted access to the finest-grained cherts was an issue, it does not appear to have motivated toolmakers at Mt.

Trumbull to conserve it. The lack of conservation seems to also suggest that the finer chert did not have any particular social or economic value compared to the other types.

At only one site was there evidence of a possibly different treatment between the materials. The finer chert may have been conserved to some degree at site 14 (MNA). At this site the percentage of tools made of Category 2 material was higher than at the other five sites (26.2 percent, compared to 4.8 to 16.1 percent), and all recovered complete flakes of Category 2 chert that were large enough to be used as tools seemed to have been put to use. It would be interesting to learn if this is the result of a true preference for the material, and what might have prompted them to use it more often. Perhaps a detailed use wear analysis of these tools in the future would provide insight as to whether the choice to use the finer-grained chert was related to the type of task being conducted.

3. With whom (geographically) did the Virgin Anasazi of Mt. Trumbull interact to acquire obsidian?

The results of the obsidian chemical sourcing show that interaction occurred between the people of Mt. Trumbull and populations south of the Grand Canyon and in southwest Utah, and that there may have been down-the-line trade with groups in southwestern Nevada. Thus, the research here supports the chemical sourcing findings by Lesko and Nelson and ties it in with the current Virgin Anasazi trade network paradigm.

Although it is impossible to know precisely if individuals from Mt. Trumbull visited the source locations themselves or traded with people from those areas, we can be sure they had relationships, familial and/or economic, with people in these other regions. As

could be the case with upland/lowland exchange of Moapa Gray Ware discussed in Chapter 2 and the latter part of Chapter 5, perhaps obsidian moved among individuals or households having personal relationships. It may have been traded during social events meant to bring larger numbers of people together for group hunts, sports, or ceremonial practices. Obsidian may have also been transported by people who specialized in trade, possibly based in either the Mt. Trumbull area or the regions in which the sources were located. Although obsidian trade practices carried out by individuals near the source locations was not within the scope of this project, further research on the Arizona and Utah obsidian localities could conceivably reveal a network of professional traders originating from, or passing through, the source areas to barter with surrounding groups.

Given the frequent contact known to have occurred between the inhabitants at Mt. Trumbull and Moapa Valley, it is somewhat surprising that no obsidian was recovered from sources utilized by southern Nevada residents. At this point I am not aware of reports of sourcing having been conducted on obsidian found in Moapa Valley, but the few samples of obsidian sourced from sites in the Las Vegas Valley having Moapa Gray Ware were found to be from southern Nevada (Shoshone and Tempiute Mountains) and southeastern California (Coso Volcanic region). If Mt. Trumbull toolmakers had wanted to procure obsidian, it seems they would have had some opportunity to do so through their neighbors to the west, but this does not so far appear to be the case. Thus, there was some cause to interact with people to the north and south. Many other types of trade goods may have been exchanged along these routes, but what these items would have been has not yet been part of the published discussion on Virgin Anasazi trade. Of most importance, the new information revealed from the Mt. Trumbull obsidian indicates a

more dynamic interaction system through the Virgin Anasazi region than that which has been previously understood.

4. Is obsidian treated as an exotic material at Mt. Trumbull?

A toolstone is more expensive if its procurement requires more energy, or access to it is otherwise restricted. In the case of Mt. Trumbull, obsidian is rarely found due to it being a non-local resource and would fit the description of an expensive or exotic material type.

In answering this question, I am only including the obsidian from the six Mt. Trumbull sites, and not any of the samples from the SUU collection, because the sampling methods used during the surveys in the 1970s are unknown, and only tools may have been collected at that time. The Mt. Trumbull obsidian sample also includes all of the obsidian collected during the field schools through 2006, not just those included in the flaked stone analysis.



Figure 15. Obsidian projectile point recovered during the Mt. Trumbull field school.

Based on the materials from Mt. Trumbull, obsidian was more likely than other types of material to be found in the forms of tools and late-stage debitage, but not, perhaps, to the degree that one would expect if it were considered to have been extremely rare. The sample included one projectile point (Figure 15), one biface fragment, one drill, one edge-modified flake, 11 utilized flakes, and five pieces of unutilized debitage. While 75 percent of this group was in the form of tools, only three were formal tools, suggesting there was not a great effort to conserve the material. This conclusion is somewhat unexpected given the extremely low quantities of obsidian found in the area. The high percentage of flakes in the assemblage implies that obsidian cores were brought to Mt. Trumbull rather than finished tools. Obsidian does not appear to have been considered a highly valued commodity or to have had any cultural significance beyond its occasional use as a sharp-edged stone. Perhaps there was limited contact between the Virgin Anasazi on the Uinkaret Plateau and individuals near the Arizona and Utah obsidian sources. The energy needed to obtain obsidian may not have been worth the effort given the presence of adequate chert toolstone in the area. Were burials ever to be excavated at Mt. Trumbull, the presence of obsidian as a grave good could imply that it was treated more as an exotic toolstone than I have been able to determine with this analysis.

Summary

Using the results of flaked lithic assemblage analyses from six Mt. Trumbull sites and chemical sourcing of obsidian samples from the surrounding area, this study has been able to identify some of the upland Virgin Anasazi behaviors associated with lithic tool production, varieties of site activities, the treatment of varying qualities of raw lithic materials, and interaction among regional groups.

A wide range of lithic reduction stages occurred; however, low quantities of flakes with cortex suggest cores were procured without weathered surfaces, or cortex was largely removed elsewhere before cores were brought to the site. The number of cores at the sites was also relatively low, which led to some consideration that flakes may have

been brought into the sites after being removed from their cores. Mid-stage flakes were the most common debitage type found at all sites, although site AZ:A:12:14 (MNA) appears to have had a greater amount of late stage debitage in comparison to the other sites. Late-stage debitage may also be underrepresented in the assemblage due to the difficulties involved in retrieving the smallest artifacts at archaeological sites.

Rather than make an effort to identify specific activities at the Mt. Trumbull sites based on lithic analysis, the variety of tool types was used to compare the sites to each other with regard to behaviors. For the most part, the sites had similar types of tools (primarily utilized flakes, edge-modified flakes, burins, scrapers, bifaces, and projectile points), despite the sites being of different sizes and having varied lengths of occupation and varied assemblage quantities. One site contained two of an unusual tool type in close proximity to each other: a three-sided burin of sorts, which may indicate that one or more contemporaneous individuals preferred a different type of tool or conducted a unique activity at that location.

Although a fine-grained chert was available to the inhabitants at Mt. Trumbull, they appear to have used a medium-grained chert most often for tool production, and even courser cherts were used with regularity. There was only occasional evidence that the fine-grained material was conserved in any way.

Despite obsidian being rarely found around Mt. Trumbull, it was not treated as a highly valuable material. It was more often recovered as tools and late-stage debitage, but was rarely found as formal tools. Utilized flakes were the most common form of obsidian at the sites, which suggests obsidian was only viewed as a relatively normal toolstone rather than a socially or economically valuable item.

Research on the Virgin Anasazi had formerly revealed interaction between groups to the east and west of the Mt. Trumbull area through data that had been collected on the transport of pottery, shell, and turquoise. According to the obsidian sourcing data, the Virgin Anasazi also participated in social and/or economic interactions with populations to the north and south of Mt. Trumbull. Obsidian from this project was found to have originated from north-central Arizona, south of the Grand Canyon, and from southwestern Utah.

Conclusions

This thesis has shown that a wide range of activities that required the use of stone tools occurred at habitation sites at Mt. Trumbull, and toolmakers had enough material available to them such that they did not need to expend large amounts of time and energy on acquiring their lithic resources. Obsidian was occasionally available to them, but was not so difficult to obtain or especially valued that it was highly conserved. The inhabitants of Mt. Trumbull obtained their obsidian through a dynamic system of interaction, but from different groups than those from which they acquired pottery, shell, and turquoise. The evidence suggests these interactions were generally social in nature or relatively simple economic transactions rather than part of a highly complex exchange system.

If an opportunity arises to obtain a more detailed site chronology at Mt. Trumbull, our understanding of the Virgin Anasazi would benefit from looking at changes in these behaviors over time and gathering data to update the Pecos Classification for this area. Some excavation in the area would allow for more detailed temporal site occupation data,

especially if charcoal from hearths within fully-excavated dwellings could be dated. Another potential avenue of research would be to compare the lithic assemblages of nonhabitation sites with the results of this thesis to determine if different behavioral patterns may be discovered. Particularly of interest would be the investigation of sites where raw lithic material would have been collected to determine if the earliest stages of core reduction occurred at quarries or if materials were available in their raw form without cortex. To improve our understanding of Virgin Anasazi upland-lowland interaction, it would be helpful to perform obsidian sourcing analysis on artifacts recovered from the Moapa Valley. Did Moapa Valley groups acquire obsidian from the same Utah and Arizona sources as their upland associates near Mt. Trumbull or from the Nevada and California sources used by Las Vegas Valley inhabitants? As is so often the case, this research has addressed some important questions about the Virgin Anasazi, but also generated even more.

APPENDIX 1

DEFINITIONS

<u>Attributes</u>	
Bulb of force:	The bulbar location on the ventral surface of a flake that was
	formed as a result of the Hertzian cone turning toward the outside of the objective piece.
Cortex:	The chemically or mechanically weathered surface of a stone.
Dorsal surface:	The side of a flake or detached piece that shows evidence of previous flake removals or the original surface of the rock.
Eraillure:	The small scar that is sometimes located on the bulb of force.
Facet:	A flat surface or plane on a flake platform.
Grinding:	Abrasion placed on a platform before the flake is removed.
Negative flake scar:	The concave scar that remains on the core which indicates the location from which a flake was removed.
Platform:	The surface of a piece of toolstone which is struck or pressed to remove a flake.
Provenience:	The location or point of recovery of an artifact.
Ripple marks:	Arc shaped features that appear as raised areas on a flake's ventral surface running in a pattern concentric to the bulb of force.
Shatter:	Debris having angular and blocky sides resulting from conchoidal fractures and lacking discernable flake attributes.
Use wear:	Damage on lithic artifacts resulting from use as a tool.
Ventral surface:	The smooth surface of a detached piece that contains no previous flake removals, but may have an eraillure flake on the bulb of force.
Tool types:	
Biface:	A tool that has two surfaces (faces that meet to form a single edge that circumscribes the tool). Both faces usually contain flake scars that travel at least half-way across the face. For the purposes of this analysis the biface stages were assigned according to Andrefsky (1998).
Burin:	A tool with a sharp bit such that it could be used for graving or chiseling.
Core:	A piece of toolstone having negative flake scars, indicating the removal of flakes.
Denticulate:	A flake tool with a serrated edge.
Edge-modified flake:	A flake having purposefully removed smaller flakes along an edge in order to create a tool with an edge suitable for a particular task.
Scraper:	A flake having a modified or utilized edge with an angle of 75° or greater.
Uniface:	A flake tool modified on either the dorsal or ventral side only.
Utilized flake:	A flake with damage or wear on an edge which may indicate use as a tool.

APPENDIX 2

OBSIDIAN LAB REPORT

X-Ray Fluorescence Analysis of Artifact Obsidian from Several Sites in Mohave County, Arizona

Craig E. Skinner Northwest Research Obsidian Studies Laboratory

Forty-one obsidian artifacts from eighteen sites in southern Mohave County, Arizona, were submitted for energy dispersive X-ray fluorescence trace element provenance analysis. The samples were prepared and analyzed at the Northwest Research Obsidian Studies Laboratory under the accession numbers 2004-127, 2005-153, and 2006-66.

Analytical Methods

X-Ray Fluorescence Analysis. Nondestructive trace element analysis of the samples was completed using a Spectrace 5000 energy dispersive X-ray fluorescence spectrometer. The system is equipped with a Si(Li) detector with a resolution of 155 eV FHWM for 5.9 keV X-rays (at 1000 counts per second) in an area 30 mm². Signals from the spectrometer are amplified and filtered by a time variant pulse processor and sent to a 100 MHZ Wilkinson type analog-to-digital converter. The X-ray tube employed is a Bremsstrahlung type, with a rhodium target, and 5 mil Be window. The tube is driven by a 50 kV 1 mA high voltage power supply, providing a voltage range of 4 to 50 kV. For the elements Zn, Rb, Sr, Y, Zr, Nb, and Pb that are reported in Table A-1, we analyzed the collection with a collimator installed and used a 45 kV tube voltage setting and 0.60 mA tube current setting.

The diagnostic trace element values used to characterize the samples are compared directly to those for known obsidian sources reported in the literature and with unpublished trace element data collected through analysis of geologic source samples (Northwest Research 2006a). Artifacts are correlated to a parent obsidian source (or geochemical source group) if diagnostic trace element values fall within about two standard deviations of the analytical uncertainty of the known upper and lower limits of chemical variability recorded for the source. Occasionally, visual attributes are used to corroborate the source assignments although sources are never assigned solely on the basis of megascopic characteristics.

Additional details about specific analytical methods and procedures used for the analysis of the elements reported in Table A-1 are available at the Northwest Research Obsidian Studies Laboratory World Wide Web site at *www.obsidianlab.com*.

Results of Analysis

X-Ray Fluorescence Analysis. Nine geochemical obsidian groups, seven of which were correlated with known sources located in Arizona, Utah, and Nevada, were identified among the 41 obsidian artifacts that were characterized by X-ray fluorescence analysis. The locations of the sites and the identified sources are shown in Figure 1. Analytical results are presented in Table A-1 in the Appendix and are summarized in Table 1 and Figure 2.

Table 1. Summary of results of trace element studies of artifacts from the project sites.

					Ö	bsidian Sources				
Project Site	Black Rock Area	Black Tank	Government Mountain	Modena	Mt. Hicks	Partridge Creek (Round Mountain)	Unknown Type B	Unknown Type C	Wild Horse Canyon	Total
AZ:A:12:30 (BLM)	b	1) -		S				5
AZ:A:12:52 (MNA)	< 3	a) L	4.	4.	ф.	-	τ	J	1	2
AZ:A:12:131 (BLM)		J		. K	N.	<u></u>	1	1	I	4
AZ:A:12:136 (ASM)	2	Ф	1	I	4	-	1	ıî.	I	3
AZ:A:12:204 (BLM)		() ()							I	1
AZ:A:12:223 (ASM)	. 1	ſ	1	1		1	1	Ţ	I	1
BLM Rd. #5		1		1	4		T	1.	Ι	1
GC-663	1.	4		£	Î	·++	ť	$\{\mathbf{T}_i^{(i)}\}$	Ι	12
GC-689	1 A			1	l.	- J	Ŷ	1	Ι	1
GC-754	4			.1		long 2	-	I	Ι	1
GC-777		E.		E	Ť		£	F	1	1
CG-781	-	1		z	i i	-		I I	Ι	2
GC-787		1					1	ų.	I	1
GC-908		¢.		I		teres i	Ţ.	1	Ι	1
GC-946	÷.	ł							Ι	1
Random Find				ł		ĵ	j,	1	I	1
T061704PB04	E -	1			Ĵ.				Ι	2
T070306PB01				- , I ,	Ĭ i		1		-	1
Total		9	2	12		15	100	T	3	41



Figure 2. Scatterplot of strontium (Sr) plotted versus zirconium (Zr) for all analyzed artifacts.

The sources identified in the current investigation are described by Ericson (1976), Nelson (1984), Lesko (1989), and Shackley (1990, 1995, 2005). The two unknown obsidian sources are the same as the Unknown Type B and Unknown Type C varieties that have been found at several sites in eastern Nevada and western Utah (Haarklau et al. 2005).

Additional descriptive information about the obsidian sources found in the current investigation may be found at *www.sourcecatalog.com* (Northwest Research 2006b).

References Cited

Ericson, Jonathon E., T. A. Hagan, and C. W. Chesterman.

- 1976 Prehistoric Obsidian in California II: Geologic and Geographic Aspects. In *Advances in Obsidian Glass Studies*, edited by R. E. Taylor, pp. 218-239. Noyes Press, Park Ridge, New Jersey.
- Haarklau, Lynn, Lynn Johnson, David L. Wagner, Richard E. Hughes, Craig E. Skinner, Jennifer J. Thatcher, and Keith Myhrer
 2005 Fingerprints in the Great Basin: The Nellis Air Force Base Regional Sourcing Study. Report prepared for Nellis Air
 Force Base by Prewitt and Associates, Inc., Austin, Texas.

1989 A Reexamination of Northern Arizona Obsidians *Kiva* 54:385–399.

Nelson, Fred W., Jr.

1984 X-Ray Fluorescence Analysis of Some Western North American Obsidians. In Obsidian Studies in the Great Basin, edited by Richard E. Hughes, pp. 27–62. Contributions of the University of California Archaeological Research Facility No. 45, Berkeley, California.

Northwest Research Obsidian Studies Laboratory

- 2006a Northwest Research Obsidian Studies Laboratory World Wide Web Site (www.obsidianlab.com).
- 2006b Northwest Research U. S. Obsidian Source Catalog (www.sourcecatalog.com).

Shackley, M. Steven

- 1990 *Early Hunter-Gatherer Procurement Ranges in the Southwest: Evidence from Obsidian Geochemistry and Lithic Technology.* Unpublished Ph.D. Dissertation, Department of Anthropology, University of Arizona, Tempe, Arizona.
- 1995 Sources of Archaeological Obsidian in the Greater American Southwest: An Update and Quantitative Analysis. American Antiquity 60:531–551.
- 2005 Obsidian: Geology and Archaeology in the North American Southwest. The University of Arizona Press, Tueson, Arizona.

Lesko, Lawrence M.

					Trace	Elem	ent Co	meent	ration	30			Ratio		
Site	Catalog No.	Zn	Ph	Rb	$\mathbf{S}_{\mathbf{r}}$	≻	Zr	q	H.	Mn	Ва	Fe^2O^{3T}	FerMn	FeiTi	Geochemical Source
AZ:A:12:30 (BLM)	Д.	¥ =	49 5	293 5	6 01	45	102	80.01	MN	NN	NN NN	MN	18.0	54.0	Partridge Creek (Round Mountain) *
AZ:A:12:30 (BLM)	10	= 10	39	251 5	× C	4 o	93	30	MN	MN	MN	NN	18.8	72.6	Partridge Creek (Round Mountain) *
AZ.A.12.30 (BLM)	á l	47 = 10	36	240	6 (I	3 m	06	52	MN	MN	MN	MN	23.0	1.04	Partridge Creek (Round Mountain) *
AZ:A:12:30 (BLM)	26	43 = 10	44	274	2.0	4 w	001	8.2	MN	MN	MN	MN	721	85.4	Partridge Creek (Round Mountain) *
AZ:A:12:30 (BLM)	<u>(</u>)	50 10	48 4	275 5	6 0	đ w	96 10	8 4	MN	MN	MN	MN	17.3	83.0	Partridge Creek (Round Mountain) 🍁
AZ.A. 12:52 (MNA)	27	₫ °	5 4	234 5	6 4 6	33	124 10	12	MN	MN	MN	MN	20.8	20.2	Wild Horse Canyon *
AZ:A:12:52 (MNA)	28	38 11 =	5 5	289 5	° ∃	4 m	101	8 0	MN	MN	MN	NN	16.6	52.0	Partridge Creek (Round Mountain) *
AZ:A:12:131 (BLM)	È.	-45 10	\$ 0	268 5	9.9	$\frac{1}{2}\omega$	103	38	MN	NMN	MN NN	NN	17.6	80.4	Partridge Creek (Round Mountain) *
AZ:A: (2:131 (BLM)	- Ť	46 = 10	12.5	5 2 2 2	90 9	33	132 16	5 5	NN	MN	MN	MN	32.9	43.9	Modena •
AZ;A:12:131 (BLM)	ж,	35	39	218 5	6	87	128	24	MN	MN	MN	NN	31.5	42.4	Modena *
AZ:A:12:131 (BLM)	52	51 = 10	ŝ	208 5	\$ °	27 X	125	2 6	NN	MN	MN	NN	31.1	35.7	Modena **
AZ.A.12.136 (ASM)	Ċ.	70 9	$^{40}_{4}$	121	8	<u>8</u> %	86 10	S ci	339 88	542 28	266	0.78	12.6	75.0	Government Mountain
AZ:A:12:136 (ASM)	8	= 10	\$ 7	277 5	91	\$ m	102	\$ 11	MN	MN	MN MN	MN	18.0	90.5	Partridge Creek (Round Mountain) *
AZ:A:12:136 (ASM)	24	36 =)10	\mathcal{E}_{\pm}	207 5	62 6	\overline{m} in	133	<u>6</u> 0	MN	MN	MN	NN	30.5	35.4	Modena **
AZ:A:12:204 (BLM)	8	5 g	39	173	90	5 %	102 10	61	604 88	329	33	0.57	15.9	33.4	Mt. Hicks
AZ:A:12:223 (ASM)	54	.33 = 12	8 9	243 5	<u>n</u> e	38 %	94 10	8 0	MN	MN	MN	MN	16.1	58,1	Partridge Creek (Round Mountain) *

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		į.			Trace	Eleme	ant Cc	ncent	rations				Rati	so	
Site	Catalog No.	Zn	Pb	Rb	Sr	γ	Zr	Nb	Ţ	Mn	Ba	Fe^2O^{3T}	Fe;Mn	Fe:Ti	Geochemical Source
BLM Rd. #5	2)	38 10	5 5	217 5	98 9	96	131 10	5 6	1024 90	436 28	483 32	0.96	U6)	32.1	Modena
GC-663	30	43 ± 10	36	124	901	5 ~	8	29	MN	WN	MN	MN	23.9	27.6	Black Tank *
GC-663	01	24 ± 13	25 2	187 5	74 9	5 %	115	30 (1	1073 90	370	416 32	0.66	16.0	21.8	Modena
GC-663	Ξ.	53 ± 10	36.2	<u>5</u> 4	114 9	3.0	96 10	80	MN	MN	MN	MN	30.5	44.7	Black Tank *
GC-663	Ŧ	46 + 10	37 5	245	6 E	38	16	50	735 89	387 28	ΞĒ	89.0	15.6	32.)	Partridge Creek (Round Mountain)
GC-663	33	5 C	<u>د</u> ا	204 5	83 9	81 m	155 10	<u>8</u> °1	MN	MN	405	MN	31.7	39.8	Moderta *
GC-663	7.	46 ± 11	4 0	246 5	QN N	4 m	96 97	8 9	MN	MN	32	MN	10.4	89.0	Partridge Creek (Round Mountain) *
0C-663	35	38 ± 11	48 5	245	8.5	\$ n	93	5	MN	MN	0.16	MN	(6.3	39.8	Partridge Creek (Round Mountain) *
GC-663	36	49 ± 11	33	203	8 0	33	126	<u> </u>	883	408	5 1 55 55	0.62 0.11	13.7	35.0	Moderra
GC-663	37	55 10	6† 5	243	≓£	4 F	5 S	¥ 4	624 88	531	- 31	0.77 0.11	12.8	42,4	Partridge Creek (Round Mountain)
GC-663	38	58 10	26 5	156	101 9	38	202	3 2	1344 91	297 28	1017	11.06	30.9	27.1	Unknown Type C
GC-663	54	45	28	5	<u>121</u> 9	ti u	5	8 11	MN	MM	638	MN	29.6	28.4	Black Tank *
0C-663	43	± 10	q v	$\overline{\mathcal{V}}_4$	114 9	\overline{n} \overline{n}	96 01	ର ମ	1464 91	327	794 32	E(3)	30.1	26.8	Black Tank
GC-689	52	40 ±	3 x	260 5	8.8	88 10	97	53	NN	MN	0.6	NN	172	100.4	Partridge Creek (Round Mountain) *
GC-754	46	4 11 11	37 5	204	82 9	8 c	139	50	MN	MN	MN	MN	29.6	41.8	Modena *
GC-777	47	4 1 4	8 5	197 5	41	33	115 15	21	MN	MN	126 32	MN	6.61	32.2	Wild Horse Canyon *

Site Catal GC-781 4 GC-781 4 GC-781 4 GC-787 5 GC-908 4		1	de		l'race.	Elem	ent Co	ncenti	ations		, 10 1	1 m m m	Rati	SO	
6C-781 4 6C-781 4 6C-787 5 6C-787 5	og No.	Zn	Ъb	Rb	Sr	Y	Zr	ŊŊ	TT	Mn	Ball	ecO3T	Fe:Mn	FerTi	Geochemical Source
GC-781 4 GC-787 5 GC-908 4	52	49 = 11	30	203	98 9	ξ, r	146	2 4	MN	MN	408 32	NM	26.5	37.0	Modena *
GC-787 5 GC-908 4	Ξ	38	92 %	203	62	33	123	2 1	MN	MN	371	NN	26.2	45,3	Modens *
GC-908 4	0	5 9 9	27 5	5 4	6 1 6	8 0	56 10	36	1231 91	608 28	742 32	1.29 0.11	18.0	35.6	Bluck Tank
	6	80	5	<u></u>	125	8 %	303	Rri	MN	MN	1079 33	MN	29.2	37.6	Unknown Type B *
GC-946 4	80	8 =	36	4	8 <u>7</u> 6	3 6	8 9	\$ CI	MN	MN	245 32	NM	14.8	94.5	Government Mountain *
Random Find 3	5	12 23	37 6	256 5	5	51	66 01	8 0	MN	NN	កក	MN	20,3	75.9	Black Rock Arca *
T061704PB04 2	50	45 10	R 4	4	125 9	9, 9	96 10	6 61	MN	MN	MN	WN	23.5	25.6	Black Tank *
1061704PB04	્રે	19 19	52 5	277 5	6 6	6 %	99	36	MN	MN	MN	MN	18.3	25.2	Partridge Creek (Round Mountain) *
1070306P301	53	27 13	8 9	5	94 94	30	120	2 51	795 90	284 27	446 32	0.84	26.0	36.2	Modena
NA RG	I-W	27 = 11	27 4	158.	5 9	37	10	9.12	1629 92	289	WN	1.96 0.11	57.1	40.4	RGM-1 Reference Standard

APPENDIX 3

OBSIDIAN SOURCE DESCRIPTIONS

Arizona Obsidian Sources (Shackley 2005)

The distances of Arizona sources from Mt. Trumbull reported below are linear measurements and do not take into account that the Grand Canyon lies between the two and would have greatly increased the travel distance required to carry material to Mt. Trumbull.

Partridge Creek (Round Mountain)

Located in southwest Coconino County, Arizona. Nodules come from a rhyolite ash flow primarily on the southeast side of Round Mountain. Secondary deposits are found in Partridge Creek drainage within an area of 15-20 km in length. Most nodules are around 10 cm in diameter, but can surpass 16 cm. Densities of nodules in the area can reach 10 per sq m. While no quarry-type sites have been found there, test knapping seems to have occurred throughout the location. The material is an opaque black. Partridge Creek is approximately 67 miles south-southeast of Mt. Trumbull. Obsidian from this source makes up 36.6 percent of the project sample.

Black Tank

Located north of Round Mountain. The material, also known as Rose Well obsidian, occurs as black or black and mahogany nodules under five centimeters in size. It is nearly visually identical to Partridge Creek obsidian but has a very different chemistry. This source is located approximately 54 miles southeast of the project area. Obsidian from Black Tank makes up 14.6 percent of the project sample.

Government Mountain

Located in south-central Coconino County, Arizona. Nodules of this gray-black, high quality material up to 15 cm in diameter can be found around the base of the dome structure and in secondary contexts within 2 km of the base. Cores and flakes occur in densities up to 200 per five sq. m., along with occasional broken preforms. Its use was common from Paleoindian through historic periods. The source is located approximately 100 miles southeast of the project area. Obsidian from Government Mountain makes up 4.9 percent of the project sample.

Utah Obsidian Sources (Haarklau et al. 2005)

Black Rock Area

Located in the Black Rock Desert of Millard County, Utah. Contains obsidianbearing rhyolite which erupted approximately 2.5 million years ago. The source is approximately 160 miles north-northeast of Mt. Trumbull. Obsidian from this source makes up 2.4 percent of the project sample.

Modena Area

Located near Modena, Iron County, Utah. Found in alluvial deposits in the form of boulders, cobbles and pebbles, eroding eastward out of the Steamboat Mountain Formation. Modena is located approximately 85 miles northwest of the Mt. Trumbull area. Obsidian from this source makes up 29.2 percent of the project sample.

Wildhorse Canyon

Located in the Mineral Mountains, Beaver County, Utah. Blocks of obsidian up to onehalf meter in diameter have been identified. They are found within the lower two of three stratigraphically distinct rhyolitic rock sequences which erupted between 800,000 and 500,000 years ago along the crest of the Mineral Mountains. This source is located approximately 140 miles north of the Mt. Trumbull project area. Obsidian from Wildhorse Canyon makes up 4.9 percent of the project sample.

Nevada Obsidian Source (Haarklau et al. 2005)

Mt. Hicks

Located on the east side of Mt. Hicks in Mineral County, Nevada. Material in both primary and secondary contexts appears on the northeast and southeast sides of the mountain. Mt. Hicks is located approximately 330 miles northwest of the Mt. Trumbull area. The single piece of obsidian from this source makes up 2.4 percent of the project sample.

BIBLIOGRAPHY

Ahlstrom, R. V. N. and J. D. Lyon

2004 Las Vegas Valley site distribution analysis. In *An Archaeological survey for the Las Vegas Valley disposal boundary environmental impact statement, Clark County, Nevada*, edited by R. V. N. Ahlstrom, S. Eskenazi and H. Roberts. Report prepared for PBS&J, Henderson, Nevada and the BLM Las Vegas Field Office. BLM Report No. 5-2467.

Aikens, C. M.

1966 *Virgin-Kayenta cultural relationships*. University of Utah Anthropological Papers, No. 79, Salt Lake City.

Allison, J. R.

2000 Craft specialization and exchange in small-scale societies: a Virgin Anasazi case study, Ph.D. dissertation, Arizona State University. University Microfilms, Ann Arbor.

Altschul, J. H. and H. C. Fairley

1989 Man, models and management: an overview of the archaeology of the Arizona Strip and the management of its cultural resources. Dames & Moore Inc. Submitted to Report prepared for USDA Forest Service, USDI Bureau of Land Management. Copies available from Contract No. 53-8371-6-0054.

Amick, D. S. and R. P. Mauldin

1989 Comments on Sullivan and Rozen's 'Debitage analysis and archaeological interpretations'. *American antiquity* 54(1):166-168.

1997 Effects of raw material on flake breakage patterns. *Lithic technology* 22(1):18-32.

Andrefsky, W., Jr.

1994 The geological occurrence of lithic material and stone tool production strategies. *Geoarchaeology* 9(5):375-391.

Andrefsky, W. J.

1998 *Lithics: macroscopic approaches to analysis.* Cambridge University Press, New, York.

Bamforth, D. B.

1986 Technological efficiency and tool curation. *American antiquity* 51(1):38-50.

1991 Technological organization and hunter-gatherer land use: a California example. *American Antiquity* 56(2):216-234.

Barton, C. M.

1990 Beyond style and function: a view from the Middle Paleolithic. *American anthropologist* 92(1):57-72.

Baugh, T. G. and F. W. Nelson

1987 New Mexico obsidian sources and exchange on the southern Plains. *Journal of field archaeology* 14(1987):313-29.

Bayman, J. M. and M. S. Shackley

1999 Dynamics of Hohokam obsidian circulation in the North American Southwest. *Antiquity* 73(282):836-45.

Bennyhoff, J. A. and R. E. Hughes

1987 Shell bead and ornament exchange networks between California and the western Great Basin. Anthropological papers of the American Museum of Natural History, v. 64, pt. 2. American Museum of Natural History, New York, N.Y.

Billingsley, G., W. K. Hamblin, J. L. Wellmeyer and S. L. Dudash 2001 Geologic Map of Part of the Uinkaret Volcanic Field, Mohave County, Northwestern Arizona. U.S. Geological Survey, Flagstaff.

Binford, L. R.

1979 Organization and formation processes: looking at curated technologies. *Journal of Anthropological Research* 35(3):255-273.

Bradbury, A. P. and P. J. Carr

1999 Examining stage and continuum models of flake debris analysis: an experimental approach. *Journal of archaeological science* 26:105-116.

Buck, P. E.

2005 *Results of field investigations in the Grand Canyon-Parashant National Monument during the summer of 2004.* Desert Research Institute. Report produced for the BLM Interagency Office, St. George, Utah.

2006 *Report of the 2005 field season, Mt. Trumbull prehistory project.* Desert Research Institute. Report produced for the BLM Interagency Office, St. George, Utah.

No date *Preliminary report of archaeological research at Uinkaret Pueblo, AZ:A:12:14(MNA).* (Ceramic analysis by Laureen Perry.) Desert Research Institute. Report produced for the BLM Interagency Office, St. George, Utah.

Buck, P. E. and S. Sakai

2006 *Ceramic exchange between the Great Basin and Uinkaret Plateau: evidence from Mt. Trumbull, Northwestern Arizona.* Poster presented at the Great Basin Anthropological Conference, Las Vegas, NV.

Carr, P. J.

1994 The Organization of technology: Impact and potential. In *The Organization of North American prehistoric chipped stone tool technologies*, edited by P. J. Carr, pp. 1-8. International Monographs in Prehistory, Ann Arbor.

Carr, P. J. and A. P. Bradbury

2001 Flake debris analysis, levels of production, and the organization of technology. In *Lithic Debitage: context, form, meaning*, edited by W. Andrefsky. University of Utah Press, Salt Lake City.

Dalley, G. F. and D. A. McFadden

1985 *The Archaeology of the Red Cliffs site*. Cultural Resource Series No. 17. Bureau of Land Management Utah State Office.

1988 *The Little Man archaeological sites: excavations on the Virgin River near Hurricane, Utah.* Cultural Resource Series No. 23. Bureau of Land Management Utah State Office, Salt Lake City.

- Dibble, H. L., U. A. Schurmans, R. P. Iovita and M. V. McLaughlin
 2005 The Measurement and Interpretation of Cortex in Lithic Assemblages.
 American Antiquity 70(3):545.
- Dixon, J. E., J. R. Cann and C. Renfrew
 1968 Obsidian and the origins of trade. *Scientific American* 218(3):38-46.

Ezzo, J. A., M. A. Sterner and T. Majewski

1996 A Class I cultural resources survey of the Moapa and Virgin Valleys, Clark County, Nevada. Statistical Research technical series, no. 58. Statistical Research Inc., Tucson.

Fladmark, K. R.

1982 Microdebitage analysis: Initial considerations. *Journal of Archaeological Science* 9(2):205.

Frison, G. C.

1968 A functional analysis of certain chipped stone tools. *American Antiquity* 33(2):149-155.

Gould, R. A., D. A. Koster and A. H. L. Sontz

1971 The Lithic assemblage of the Western Desert Aborigines of Australia. *American Antiquity* 36(2):149.

Haarklau, L., L. Johnson and D. L. Wagner

2005 *Fingerprints in the Great Basin: the Nellis Air Force Base regional obsidian sourcing study.* Report prepared for Nellis Air Force Base by Prewitt and Associates, Inc., Austin Texas.

Harrington, M. R.

1927 A Primitive pueblo city in Nevada. *American Anthropologist* 29(3):262.

Harry, K. G.

1989 Obsidian assemblage from Homol'ovi III: social and economic implications. *Kiva* 54(3):285-296.

Hatch, J. W.

1990 Hopewell obsidian studies: behavioral implications of recent sourcing and dating research. *American antiquity* 55(1990):461-79.

Hayden, B. and W. K. Hutchings

1989 Whither the billet flake? *Experiments in lithic technology*. BAR International Series; v. 528:235-257.

Hayter, A. J.

1986 The Maximum familywise error rate of Fishers least significant difference test. *Journal Of The American Statistical Association* 81(396):1000-1004.

Henry, D. O.

1989 Correlations between reduction strategies and settlement patterns. In *Alternative approaches to lithic analysis*, edited by D. O. Henry and G. H. Odell. Westview Press, Boulder.

Hughes, R. E.

1994 Mosaic patterning in prehistoric California-Great Basin exchange. In *Prehistoric exchange systems in North America*, edited by T. G. Baugh and J. E. Ericson, pp. 363-383. Plenum Press, New York.

Janetski, J. C.

2002 Trade in Fremont society: contexts and contrasts. *Journal of Anthropological Archaeology* 21:344-370.

Jensen, E. A. and M. C. Slaughter

2009 *Back to the old salt mines*. Paper presented at the Three Corners Conference, University of Nevada, Las Vegas.

Jeske, R.

1989 Economies in raw material use by prehistoric hunter-gatherers. In *Time, energy and stone tools*, edited by R. Torrence. Cambridge University Press, New York.

Johnson, J. K.

1986 Amorphous core technologies in the Midsouth. *Midcontinental journal of archaeology* 11(2):135-151.

Jones, G. T., C. Beck, E. E. Jones and R. E. Hughes

2003 Lithic source use and Paleoarchaic foraging territories in the Great Basin. *American antiquity* 68(1):5-38.

Jones, G. T., D. K. Grayson and C. Beck

1983 Artifact class richness and sample size in archaeological surface assemblages. In *Lulu linear punctated: essays in honor of George Irving Quimby*, edited by R. C. Dunnell and D. K. Grayson. University of Michigan, Ann Arbor.

Justice, N. D.

2001 Stone Age spear and arrow points of California and the Great Basin. Indiana University Press, Bloomington.

Keeley, L. H.

1982 Hafting and retooling: effects on the archaeological record. *American antiquity* 47(4):798-809.

Kelly, R. L.

1988 Three sides of a biface. *American antiquity* 53(4):717-734.

Kent, K. P.

1983 *Prehistoric textiles of the Southwest*. University of New Mexico Press, Albuquerque.

Larson, D. O.

1996 Population Growth, Agricultural Intensification, and Culture Change among the Virgin Branch Anasazi, Nevada. *Journal of Field Archaeology* 23(1):55.

Leonard, N. N., III and C. E. Drover

1980 Prehistoric turquiose mining in the Halloran Springs District, San Bernardino County, California. *Journal of California and Great Basin Anthropology* 2(2):245-256.

Leonard, R. D., F. E. Smiley and C. M. Cameron

1989 Changing strategies of Anasazi lithic procurement on Black Mesa, Arizona. In *Quantifying diversity in archaeology*, pp. 100-108. Cambridge University Press, New York.

Lesko, L. M.

1989 Reexamination of northern Arizona obsidians. *Kiva* 54(4):385-399.

Lister, R. H., J. R. Ambler and F. C. Lister

1960 *The Coombs site, part II.* University of Utah, Department of Anthropology, Anthropological Papers Number 41, Glen Canyon Series Number 8. University of Utah Press, Salt Lake City.

Lister, R. H. and F. C. Lister

1994 *Those who came before: southwestern archeology in the National Park System.* 2nd ed. Southwest Parks & Monuments Association, Tucson, Ariz.

Lopes, V. L. and P. F. Ffolliott

2001 Impacts of vegetative practices on suspended sediment from watersheds of Arizona. *Journal of Water Resources Planning & Management* 127(1):41-47.

Luedtke, B. E.

1992 An Archaeologist's guide to chert and flint. Institute of California, Institute of Archaeology, Los Angeles.

Lyneis, M. M.

1986 A Spatial analysis of Anasazi architecture, A.D. 950-1150, Moapa Valley, Nevada. *The Kiva* 52(1):53-74.

1988 Ceramic production and exchange among the Virgin Anasazi. Paper presented at the 53rd Annual Meeting of the Society for American Archaeology, Phoenix.

1992 *The Main Ridge community at Lost City: Virgin Anasazi architecture, ceramics, and burials.* University of Utah Press, Salt Lake City.

1995 Virgin Anasazi, far western Puebloans. *Journal of World Prehistory* 9(2):199-241.

1996 Pueblo II - Pueblo III change in southwestern Utah, the Arizona Strip, and southern Nevada. In *The Prehistoric Pueblo world, A.D. 1150-1350*, edited by M. A. Adler, pp. 11-28. University of Arizona Press, Tucson.

2000 Life at the edge: Pueblo settlements in southern Nevada. In *The Archaeology of regional interaction: religion, warfare, and exchange across the*

American Southwest, edited by M. Hegmon, pp. 257-274. University Press of Colorado, Boulder.

MacDonald, D. H.

2008 The Role of Lithic Raw Material Availability and Quality in Determining Tool Kit Size, Tool Function, and Degree of Retouch: A Case Study from Skink Rickshelter (46NI445), West Virginia. In *Lithic Technology: Measures of Production, Use, and Curation*, edited by W. Andrefsky. Cambridge University Press, New York.

Magne, M. P. R.

1985 *Lithics and livelihood: stone tool technologies of central and southern interior British Columbia.* Archaeological Survey of Canada Paper No. 133. National Museums of Canada, Ottawa.

1989 Lithic reduction stages and assemblage formation processes. In *Experiments in lithic technology*, edited by D. S. Amick and R. P. Mauldin, pp. 15-32. BAR International Series 528.

Martin, C.

2005 Results of Obsidian Sourcing on Artifacts from Virgin Anasazi Sites in the Mt. Trumbull Area, Arizona Strip, and a Comparison with Obsidian Samples from Virgin Anasazi Sites in Southern Nevada. Poster presented at the Graduate and Professional Student Forum, University of Nevada, Las Vegas.

Mauldin, R. P. and D. S. Amick

1989 Investigating patterning in debitage from experimental bifacial core reduction. In *Experiments in lithic technology*, edited by D. S. Amick and R. P. Mauldin, pp. 15-32. BAR International Series 528.

McBrearty, S., L. Bishop, T. Plummer, R. Dewar and N. Conard

1998 Tools Underfoot: Human Trampling as an Agent of Lithic Artifact Edge Modification. *American Antiquity* 63(1):108.

McDonald, E. K.

1994 A Spatial and Temporal Examination of Prehistorc Interaction in the Eastern Great Basin and on the Northern Colorado Plateau, Ph.D. dissertation, University of Colorado, Boulder. UMI Dissertation Services, Ann Arbor.

McFadden, D. A.

1996 Virgin Anasazi settlement and adaptation on the Grand Staircase. *Utah archaeology* 9(1):2-34.

Mills, H. H.

1986 Downslope movement of in situ clasts on forested hillslopes, Virginia. *Earth surface processes and landforms* 11:451-456.

Mitchell, D. R. and M. S. Shackley

1995 Classic period Hohokan obsidian studies in southern Arizona. *Journal of Field Archaeology* 22(3):291-304.

Moffitt, K. and C. Chang

1978 The Mount Trumbull archaeological survey. *The Western Anasazi reports* 1:185-250.

Morris, S. E. and T. A. Moses

1987 Forest fire and the natural soil erosion regime in the Colorado Front Range. *Annals of the association of American geographers* 77(2):245-254.

Morrow, C. A. and R. W. Jefferies

1989 Trade or embedded procurement? A Test case from southern Illinois. In *Time, energy, and stone tools*, edited by R. Torrence, pp. 27-33. Cambridge University Press, New York.

Morrow, T. A.

1997 A Chip off the old block: alternative approaches to debitage analysis. *Lithic technology* 22(1):51-69.

National Park Service - USDI

2007 Petrified Wood. URL: <u>http://home.nps.gov/pefo/naturescience/petrified-wood.htm</u>. Last updated 4/26/07. Accessed 4/30/09. vol. 2009.

Nelson, F. W.

1984 X-ray fluorescence analysis of some Western North American obsidians. *Obsidian studies in the Great Basin*:27-62.

Nelson, M. C.

1991 The Study of technological organization. *Archaeological method and theory* 3:57-100.

Newcomer, M. H.

1971 Some quantitative experiments in handaxe manufacture. *World Archaeology* 3(1):85.

Northwest Research Obsidian Studies Laboratory

2008 Introduction to obsidian characterization studies. URL: <u>http://www.obsidianlab.com/info_xrf.html</u>. Last updated 11/28/08. Accessed 2/4/09.

Odell, G. H.

1981 The Morphological express at function junction: searching for meaning in lithic tool types. *Journal of Anthropological Research* 37(4):319.

1989 Experiments in lithic reduction. In *Experiments in lithic technology*, edited by D. S. Amick and R. P. Mauldin, pp. 15-32. BAR International Series 528.

1996a Economizing behavior and the concept of "curation". In *Stone tools: theoretical insights into human prehistory*, edited by G. H. Odell. Interdisciplinary contributions to archaeology. Plenum Press, New York.

1996b Stone tools and mobility in the Illinois Valley: from hunter-gatherer camps to agricultural villages. Ann Arbor. International Monographis in Prehistory.

Parry, W. J.

2001 Production and exchange of obsidian tools in late Aztec city-states. *Ancient Mesoamerica* 12(1):101-11.

Parry, W. J. and R. L. Kelly

1987 Expedient core technology and sedentism. In *The Organization of core technology*, edited by J. K. Johnson and C. A. Morrow, pp. 285-304. Westview Press, Boulder.

Patterson, L. W.

1987 Amorphous cores and utilized flakes: a commentary. *Lithic technology* 16(2-3):51-53.

Perry, L. M.

2004 *Preliminary report: ceramics of AZ:A:12:14 (ASM) Uinkaret site.* Draft manuscript available from Paul Buck, Desert Research Institute, Las Vegas.

Peterson, J., D. R. Mitchell and M. S. Shackley

1997 The social and economic contexts of lithic procurement: obsidian from Classic-period Hohokam sites. *American antiquity* 62(2):231-59.

Pires-Ferreira, J. C. W.

1978 Obsidian exchange networks: inferences and speculation on the development of social organization in formative Mesoamerica. *Cultural continuity in Mesoamerica. p.*

Rafferty, K.

1990 Virgin Anasazi and the pan-Southwestern trade system, A.D. 900-1150. *Kiva* 56(1):3-24.

Rick, J. W.

1976 Downslope movement and archaeological intrasite spatial analysis. *American antiquity* 41(2):133-144.

Rowe, S. J.

2002 Evidence for Virgin Anasazi presence in the Las Vegas Valley and adjacent areas. Master's Thesis, University of Nevada.

Sakai, S.

2009 Investigation of clay sources for production of olivine-tempered ceramics in the Arizona Strip and adjacent areas in the American Southwest. Poster presented at the Society for American Archaeology annual meeting, Austin, Texas.

Schiffer, M. B.

1972 Archaeological context and systemic context. *American Antiquity* 37(2):156-65.

1975 Archaeology as behavioral science. *American anthropologist* 77(4):836-48.

1996 *Formation processes of the archaeological record*. University of Utah Press, Salt Lake City.

Schiffer, M. B. and W. L. Rathje

1973 Efficient exploitation of the archeological record: penetrating problems. In *Research and theory in current archeology*, edited by C. L. Redman, pp. 169-179. John Wiley & Sons, New York.

Shackley, M. S.

2005 *Obsidian: geology and archaeology in the North American southwest.* University of Arizona Press, Tucson.

Shott, M. J.

1994 Size and form in the analysis of flake debris: review and recent approaches. *Journal of archaeological method and theory* 1(1):69-110.

Shutler, R., Jr.

1961 *Lost City: Pueblo Grande de Nevada*. Anthropological Papers, No. 5. Nevada State Museum, Carson City.

Stahle, D. W. and J. E. Dunn

1982 An Analysis and application of the size distribution of waste flakes from the manufacture of bifacial stone tools. *World Archaeology* 14(1):84-97.

Stevenson, A. E.

2008 Lithic Procurement Strategies Through Time: A Study of Obsidian Source Utilization in Washington County, Utah. Poster presented at the 31st Biennial Great Basin Anthropological Conference, October 8-11, 2008, Portland, Oregon. Sullivan, A. P. and K. C. Rozen

1985 Debitage analysis and archaeological interpretation. *American antiquity* 50(4):755-779.

Tabachnick, B. G. and L. S. Fidell

2007 Using multivariate statistics. Pearson/Allyn & Bacon, Boston.

Teltser, P. A.

1991 Generalized core technology and tool use: A Mississippian example. *Journal of Field Archaeology* 18(3):363-375.

Tomka, S. A.

1989 Differentiating lithic reduction techniques: an experimental approach. In *Experiments in lithic technology*, edited by D. S. Amick and R. P. Mauldin, pp. 15-32. BAR International Series 528.

Torrence, R. and G. R. Summerhayes

1997 Sociality and the short distance trader: intra-regional obsidian exchange in the Willaumez region, Papua New Guinea. *Archaeology in Oceania* 32:74-84.

Tringham, R.

1974 Experimentation in the formation of edge damage: a new approach to lithic analysis. *Journal of field archaeology* 1(1):171-196.

United States Department of the Interior, B. o. L. M. 2009 Petty Sawmill <<u>http://www.blm.gov/az/st/en/prog/recreation/cultural/asfo_cultural/petty.html></u>. Accessed July 26.

Walling, B. A., K. M. Heath, L. M. W. Lindsay and G. F. Dalley
1986 *Excavations at Quail Creek*. Cultural resource series no. 20. Bureau of Land Management, Utah State Office, Salt Lake City, Utah.

Wandsnider, L.

1989 Long-term land use, formation processes, and the structure of the archaeological landscape: a case study form southwestern Wyoming. Dissertation, University of New Mexico.

Wells, S. J.

1991 *The Shivwits Plateau survey: archeology at Lake Mead National Recreation Area.* Publications in anthropology; no. 56. Western Archeological and Conservation Center, National Park Service, U.S. Dept. of the Interior, Tucson, Ariz.

Westfall, D. A.

1987 *The Pinenut site: Virgin Anasazi archaeology on the Kanab Plateau of northwestern Arizona.* Arizona State Office of the Bureau of Land Management, Phoenix.

Whittaker, J. C.

1994 *Flintknapping: making and understanding stone tools.* University of Texas Press, Austin.

Young, D. and D. B. Bamforth

1990 On the macroscopic identification of used flakes. *American Antiquity* 55(2):403-409.

VITA

Graduate College University of Nevada, Las Vegas

Cheryl M. Martin

Degrees: Bachelor of Science, Secondary Education, 1989 University of North Texas, Denton

> Master of Science, Library Science, 1991 University of North Texas, Denton

Special Honors and Awards: Nevada Historic Preservation Award, 2005 Lifetime Membership to the Archaeo-Nevada Society, 2005

Publications:

Rhode, D., R.C. Kolvet, C. Martin, and C. Shimer

2006 Class I Archaeological Site Records Search for the Proposed Mina Rail Route. Manuscript on file, Desert Research Institute, Las Vegas, NV. For submission to the U.S. Department of Energy.

Buck, P., C. Martin, and S. Sakai

2004 Surface Collection and Limited Soil Probing at the Zip Code Site (AZ:A:12:131 [BLM]). Submitted to BLM Interagency Office, St. George, Utah.

Martin, C., K. Varley, D. Page, and W.G. Johnson

- 2004 Archaeological Data Recovery at One-eyed Rabbit Site 42To0567, Dugway Proving Ground, Utah. Desert Research Institute report prepared for Dugway Proving Ground Cultural Resource Management Office. Utah Project Number U-02-DA-0385m(e).
- Thesis Title: Analysis of Flaked Stone Lithics from Virgin Anasazi Sites near Mt. Trumbull, Arizona Strip

Thesis Examination Committee: Chairperson, Barbara Roth, Ph. D. Committee Member, Karen Harry, Ph. D. Committee Member, Paul Buck, Ph. D. Graduate Faculty Representative, Stephen Rowland, Ph. D.