CHAPTER 4
MINIMUM ANALYTICAL FLAKED STONE NODULES AND CLOVIS TECHNOLOGICAL ORGANIZATION AT THE SHEAMAN SITE, WYOMING

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ABSTRACT

Minimum Analytical Nodule Analysis (MANA) can provide a powerful tool for examining prehistoric technological organization. The debitage-rich flaked stone assemblage from the Sheaman site in eastern Wyoming provides a rare opportunity to examine Clovis technological organization through MANA. Traditional interpretations of early Paleoindian technological organization view Paleoindian technology as designed to fulfill the requirements of highly mobile populations by conserving raw material and reducing the weight of the transported toolkit. Recent critiques, however, suggest that Paleoindian technology is much more variable than traditionally assumed. This paper describes the results of a MANA designed to test the validity of traditional interpretations of early Paleoindian technological organization by examining the Sheaman site flaked stone assemblage. Results of the analysis support a traditional view of early Paleoindian technological organization, and highlight several unique aspects of Clovis technological planning strategies.

INTRODUCTION

Traditional interpretations of Paleoindian technological organization view Paleoindian technology as designed to fulfill the requirements of highly mobile populations by reducing the weight of the transported toolkit and conserving raw material in the face of uncertain access to high quality source areas. Paleoindians achieved these design considerations by using high quality raw material often obtained from distant sources, extending the use lives of tools through reworking and resharpening, and increasing the portability of the toolkit by manufacturing tools for multiple uses. The need for multifunctional, long use-life tools also resulted in reliance on bifacial core technology, which is often considered another defining characteristic of the period (e.g., Amick 1999:2; Bement 1999:149; Boldurian 1991; Collins 1999:23; Custer 1984:51; Hofman 1992:199; Kelly and Todd 1988:237; Wilke et al. 1991).

Bamforth (2002) discusses the development of this traditional view of Paleoindian technological organization, rooted in the early work of archaeologists such as MacDonald (1968) and Witthoft (1952) in northeastern North America, and laid out explicitly by Kelly and Todd (1988). The theoretical model put forth by Kelly and Todd (1988) provided a comprehensive framework within which to interpret early Paleoindian behavioral and technological strategies across North America. Briefly, the model explains the extreme mobility of Clovis populations by an Arctic adaptation to large game hunting in an unpopulated environment undergoing rapid environmental change. Environmental change, coupled with resource depletion due to hunting of naïve fauna, forced Clovis foragers to move rapidly into new territories. This same hunting adaptation allowed Clovis foragers to cross ecological boundaries without having to acquire new subsistence-related knowledge. An adaptation that both permitted but also required territorial mobility could have pushed colonists southward with or without demographic pressure (Surovell 2000).

The type of Paleoindian land use this model describes has come to be called a “high technology forager” system (Kelly and Todd 1988:239), taking into account its unique combination of both collector and forager characteristics (*sensu* Binford 1980). The “high-tech forager” model came with a number of specific and archaeologically recognizable predictions regarding early Paleoindian technology and behavior. These predictions include continent-wide behavioral consistency, short-term and redundant landscape use, a technology that fulfills the requirements of a highly mobile population, and lack of long-term storage strategies. In terms of lithic technology, the high-tech forager model predicts the presence of highly curated artifacts manufactured from exotic raw materials from distant sources, a heavy reliance on bifacial technology, tools that show evidence of design for multiple uses (e.g., reuse, reworking, recycling), and conservation of raw material and extension of tool life through extensive resharpening (Kelly and Todd 1988:237-238).

Although the high-tech forager model was originally used to explain early Paleoindian, and specifically Clovis, technological and behavioral strategies, it is often extended to encompass the entire Paleoindian period (Bamforth 2002). Critics like Bamforth (2002, 2003; Bamforth and Becker 2000) have countered that few Paleoindian sites actually meet the assemblage level expectations of the high-tech forager hypothesis. For instance, Bamforth's (2002) review of published data and analysis of the Allen site lithic assemblage show that the technological predictions of the high-tech forager model are not realized at many post-Clovis Paleoindian sites. LeTourneau (2000) and Lothrop (1989) have similarly suggested that bifacial technology may not have been as central to Paleoindian lifeways as traditionally assumed.

However, as the earliest widespread occupants of North America, Clovis technological and behavioral strategies may very well be unique compared to later Paleoindian manifestations. Following Bamforth's (2002) call for more systematic assemblage-level tests of the high-tech forager hypothesis, this paper examines the lithic assemblage from the Sheaman Clovis site in eastern Wyoming. The technique of Minimum Analytical Nodule Analysis (Larson and Kornfeld 1997) is used to determine whether the assemblage fulfills the predictions of the high-tech forager hypothesis, and to assess the potential uniqueness of Clovis technological planning strategies. A brief description of the Sheaman site is first provided, followed by a discussion of Minimum Analytical Nodule Analysis (MANA) and its ability to reveal strategies of technological organization.

THE SHEAMAN SITE (48NO211)

The Sheaman site (48NO211) is a Clovis period camp site located in eastern-central Wyoming, roughly 650 m northeast of the Agate Basin site (48NO201; Figure 4.1). The Agate Basin site contains Folsom, Agate Basin, and Hell Gap components, but the Sheaman site contains the only known Clovis component within the area (Frison and Stanford 1982). Both sites are located within the Moss Agate Arroyo drainage system. The Sheaman site is

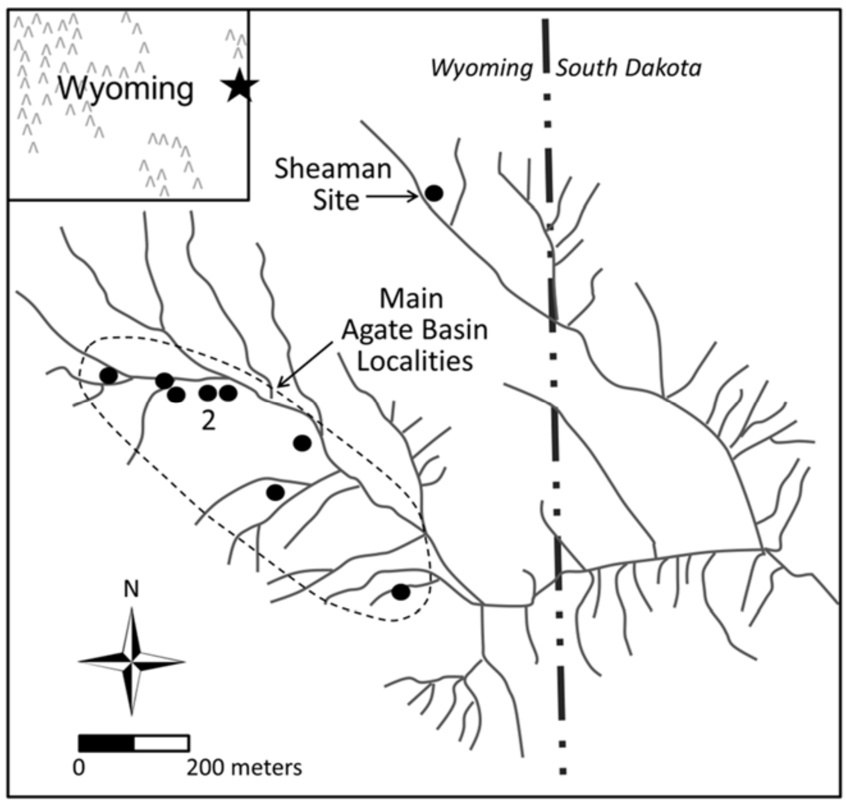


Figure 4.1 . Sheaman and Agate Basin Site locations in eastern-central Wyoming, within the Moss Agate Arroyo drainage system. Adapted from Frison and Stanford (1982:7).

located on the east bank of a tributary of Moss Agate Arroyo near a small spring that flows nearly year round (Frison and Stanford 1982).

Much of the Sheaman site was excavated by University of Wyoming crews under the direction of George C. Frison during the late 1970s (Frison and Stanford 1982). These excavations revealed what appeared to be a single component Clovis site, recovering a Clovis projectile point and a cylindrical ivory point or foreshaft with a beveled base. Also discovered during excavation were several thousand pieces of flaked stone debitage; large flake tools; red ochre-stained bison bone fragments associated with an oval-shaped, red ochre-stained area of soil; and several other light concentrations of fragmented bison bone. The presence of a newborn bison mandible suggests a spring or summer occupation. More recent investigations are being conducted by the George C. Frison Institute of Archaeology and Anthropology and the University of Wyoming to determine if additional areas of the site remain (Kornfeld et al. 2001; Meyer et al. 2005).

Much of the debitage recovered from the site epitomizes Clovis lithic technology (Bradley 1982, 2010; Stanford and Bradley 2012:49-50). For instance, large percussion biface thinning flakes are common, as are *outré passé* terminations. Refitting studies have enabled the reconstruction of biface production sequences which conform to what is known about the Clovis biface reduction/production process (e.g., Bradley 1982, 2010; Bradley et al. 2010; Frison and Bradley 1999; Stanford and Bradley 2012).

Obtaining reliable radiocarbon dates for the site has been difficult due to abundant bioturbation. Recent radiocarbon dating and stratigraphic analyses provide evidence for an age of 11,224 ± 50 ^{14}C yr BP for the Clovis occupation, based on charcoal and insoluble organic matter recovered from three bulk sediment fractions (weighted average of AA-40988, 40989, and 40991; Haynes et al. 2004). However, additional radiocarbon analyses conducted by Waters and Stafford (2007) indicate that more recent materials are also present at Sheaman. The foreshaft recovered during the 1970s excavations, initially thought to be ivory but subsequently identified as cervid bone or antler, yielded an average date of 10,305 ± 15 ^{14}C yr BP (average of UCIAMS-11675, 21992, and 21993; Waters and Stafford [2007]). Although additional investigations will be necessary to clarify issues of stratigraphic association and radiocarbon discrepancies, the lithic assemblage is assumed to be Clovis based on both the Clovis-age radiocarbon date (Haynes et al. 2004), and the technological characteristics of the assemblage (Bradley et al. 2010; Bradley 1982, 2010).

MINIMUM ANALYTICAL NODULE ANALYSIS (MANA) AND TECHNOLOGICAL ORGANIZATION

Minimum Analytical Nodule Analysis (MANA) involves classifying lithic material into analytical units, or nodules, based on raw material types, followed by sorting within raw material types by color, texture, inclusions, or any other differentiating characteristics (Larson and Kornfeld 1997:7). Ideally, this process results in nodules containing flakes that came off of the same piece of raw material. In other words, nodules should represent individual flintknapping events. Applications of MANA include clarifying site formation issues and assessing vertical and horizontal integrity, as well as informing on prehistoric technological organization (Larson and Kornfeld 1997). In the latter, the concern of this paper, nodule constituents themselves are examined to gain information about the flow of materials through a site (e.g., Hall 2004; Knell 2004; Larson and Kornfeld 1997; Sellet 1999; 2004). By examining the composition of nodules, it is possible to differentiate between individual production, use, and discard events within an assemblage (Larson 1994; Larson 2004). For instance, a complete nodule consisting of production debris along with the manufactured tool would indicate expedient on-site use and discard of the tool. Similarly, a nodule consisting of biface thinning flakes but lacking a biface would indicate that the biface was manufactured at the site, but then removed.

The composition of nodules, however, reflects more than simply what did or did not happen at a site. It also provides a window into the predictability of future events and informs on the overall technological organization of a cultural system (Binford 1977, 1979; Carr 1994; Kelly 1988; Nelson 1991; Torrence 1989).

The methods of MANA are similar to those of refitting, and MANA can be considered "virtual refitting" in the sense that physical refits are not necessary to infer that two flakes came from the same piece of raw material (Sellet 1999:42). Refitting can be used to supplement MANA, or MANA can be used to find refits. While it is true that MANA is based on subjective raw material sorting, making its objectivity and reliability low to medium compared to some other analytical methods (Larson 2004:9), refitting within nodules provides a high degree of reliability and objectivity to the nodule classification. The reliability of many of the nodules identified within the Sheaman assemblage has been reinforced with abundant refits. MANA is in some respects more useful than refitting alone because in spite of substantial time and energy invested in refitting studies, it is possible that very few refits will be found (Larson and Kornfeld 1997:15). With refitting, even if the researcher *knows* that two artifacts *must* fit together somehow, or must at least be very close to refitting, no information is gained unless the refit is found. In contrast, MANA in such a case still allows the extraction of technological information where traditional refitting does not.

Drawbacks to MANA (and refitting) are that both are extremely time consuming. Additionally, MANA depends on the ability to visually differentiate between nodules on the basis of physical characteristics, and so may not be possible with homogeneous raw material types (Larson 2004:15). MANA is most useful when a raw material type contains enough internal variability that individual nodules can be readily distinguished on the basis of similar color, texture, inclusions, or other differentiating characteristics. For the Sheaman site, overwhelmingly dominated by Mississippian chert which is extremely variable in terms of color, texture, and inclusions, MANA is indeed not only possible, but preferable to a traditional attribute analysis which would result in many reduction events being lumped together under one raw material category.

A final criticism of MANA (as well as refitting) is the possibility that unexcavated portions of the site contain artifacts that, when and if recovered, would alter the composition and therefore the interpretation of the nodule. In the case of the Sheaman site, Frison and Stanford (1982) concluded that very little if any of the site remained after the 1970s excavations. While excavations by the University of Wyoming in 2004 suggest that some areas may contain additional intact deposits, it is still the case that the vast majority of the site has likely been excavated.

Nodule Types

Larson and Kornfeld (1997:10) discuss two basic divisions of Minimum Analytical Nodules (or MANs): single item nodules (SIN) and multiple item nodules (MIN). SINs contain either a single flake or a single tool, while MINs contain more than one flake or various combinations of debitage, tools, and cores. Each nodule configuration implies different strategies of technological organization. For instance, if a SIN contains a tool, then the tool was manufactured at another location and transported into the site; the tool may or may not have been used at the site; it was not maintained at the site; and it was finally discarded (or lost) at the site. The nodule thus represents a strategy of tool curation (Binford 1973, 1977, 1979). A SIN that contains a single flake may represent one of the following: a resharpening episode that indicates on-site maintenance and removal of a curated item; removal of the flake from a transported core; or a transported blank that was never manufactured into a tool. Flake size and morphology can help determine which of these possibilities the SIN likely represents. In any case, tool curation and possibly maintenance are once again indicated.

Multiple item nodules containing only debitage provide evidence of on-site tool production and/or maintenance and, since the tool was not recovered along with the debitage, subsequent removal of the tool from the site. MINs containing debitage along with tools provide evidence of on-site tool manufacture, expedient use, and discard. Sellet (1999:46) notes that MINs could also have been manufactured elsewhere and transported into the site. For instance, multiple tools or tool blanks could have been manufactured off-site from the same core. As the number of items in a nodule increase, however, particularly debitage too small to make useful tools, the more likely it is that MINs represent reduction/production episodes that occurred on-site. Table 4.1 summarizes the composition of single and multiple item nodules, the behaviors that create each nodule type, and their implications for technological organization.

Table 4.1 Summary of nodule types, associated behaviors, and implications for technological organization (after Larson and Kornfeld 1997:11).

	Single Item Nodule (SIN)		Multiple Item Nodule (MIN)		
Content	flake	tool	debitage	debitage and tools	tools only
Behavior	off-site manufacture and on-site resharpening; resharpened item removed	off-site manufacture and on-site discard with no on-site maintenance	on-site tool production and/or maintenance	on-site tool production, use, and discard	on-site discard of tools manufactured off-site
Implications for Technological Organization	tool curation and maintenance	tool curation without maintenance	tool curation and/or maintenance	expedient tool manufacture and use	tool curation without maintenance

Scenarios of Raw Material Procurement, Use and Discard

Expectations of nodule composition have been modeled by Sellet (1999:61-70) for different scenarios of raw material procurement, use, and discard. These scenarios flesh out the basic SIN/MIN nodule divisions of Larson and Kornfeld (1997) and provide a useful baseline from which to interpret nodule composition. Sellet (1999:63) notes that while many possible procurement, use, and discard scenarios exist, only some are likely to have been implemented by prehistoric foragers. These scenarios are briefly discussed below.

Scenario 1. Off-site procurement, off-site manufacture, off-site use/maintenance, off-site discard. This scenario describes items within the transported toolkit that pass through the site without being used or discarded on-site. The presence of such items cannot be inferred from any part of the lithic assemblage, making them essentially archaeologically invisible, and thus not detectable with MANA.

Scenario 2. On/near site procurement, on-site manufacture, on-site use (or rejection), on-site discard. This scenario describes a locally procured piece of raw material that enters the site, is manufactured into a tool or a blank, is used expediently (or rejected), and discarded. The exploited material does not become part of the transported tool kit. Not only should the tool be present at the site, but the associated manufacturing debris should also be present. All stages of reduction should be present and refitting should be possible. Early stage reduction may be recognizable by cortical flakes.

Scenario 3. On/near site procurement, on-site manufacture, off-site use/maintenance, off-site discard. In this scenario, the manufactured item in scenario 2 becomes part of the transported toolkit and is removed from the site, rather than used and discarded on-site. Debitage in this scenario could consist of early stage debris, if something like a biface was manufactured and removed from the site. Such a scenario might be common at quarry sites. While Sellet states that little if any late stage debris should be present, debitage could consist of early and late stage debris if, for instance, a projectile point was manufactured.

Scenario 4. Off-site procurement, off-site manufacture and use, on-site use/maintenance, on-site discard. In this scenario, a tool or core of nonlocal raw material that was manufactured somewhere else is used on-site and finally discarded because it is exhausted. If a core or biface, debitage will be late stage since the item has already been exploited off-site. If a finished tool like a projectile point or scraper, associated manufacturing debitage should not be present, except for possibly resharpening flakes. In other words, the tool or core is part of the transported toolkit, and is nearly exhausted when it enters the site.

Scenario 5. Off-site procurement, off-site manufacture and use, on-site discard. This scenario is similar to Scenario 4 except that no on-site use occurs prior to the on-site discard. This is unlikely for cores and bifaces, because if a core or biface was exhausted, it probably would not have been transported to a site just to be discarded there. We can envision this scenario for finished tools however, that might have been discarded at the site without actually having been used there if they were being, or about to be, replaced. Discarded tools are likely to be exhausted or nearly exhausted. Such a tool refurbishing scenario might occur at a quarry, or a camp near a quarry. In this case, we would expect to find no associated manufacturing or maintenance debris.

Scenario 6. Off-site procurement, off-site manufacture and use, on-site use, off-site discard. In this scenario, a nonlocal piece of raw material is manufactured and possibly used off-site, is brought into the site and used, and then removed from the site. If the item is a core or biface we would expect to find late stage debitage that refits. If a finished tool was brought into the site and used and then transported off-site, the only evidence of its passage through the site might be resharpening flakes.

Scenario 7. On/near site procurement, on-site manufacture and use, off-site use, a return to on-site use, on-site discard. This scenario might be characteristic of a relatively long occupation span such as a residential base camp from which logistical forays were made. Tools manufactured (and possibly used) on-site would be transported off-site to accomplish certain tasks and then would return to the site for further use and final discard. It would be extremely difficult, however, to determine whether or not such tools were actually transported and used off-site prior to being brought back, as any maintenance or resharpening needed after off-site use would likely be done on-site. Therefore these tools would appear to have been manufactured, used, and discarded expediently even if they were not. Cores and bifaces would probably not have been used in this fashion simply because it would be simpler and more efficient to take finished tools on logistical forays.

Following a description of the types of nodules present in the Sheaman assemblage, we will return to these scenarios to help interpret Clovis technological organization.

MINIMUM ANALYTICAL NODULES AT THE SHEAMAN SITE

In 2006, I conducted a Minimum Analytical Nodule Analysis of the Sheaman site flaked stone assemblage, which consisted of 4,918 items[1]. I classified the lithic material into analytic units, or nodules, based initially on raw material types, followed by sorting within raw material types by differentiating characteristics such as color, texture, and inclusions. Seventy-nine distinct nodules were recognized within the assemblage. Fifty-three nodules are multiple item nodules, and 26 are single item nodules. Nodule composition is summarized in Table 4.2, and described below by raw material type (see Prasciunas [2008] for geologic and geographic details of the identified raw materials). Table 5.2 also provides total numbers of flakes and tools contained in the identified nodules, summed by raw material type. Raw material identifications were made or verified by Jim Miller, a geoarchaeologist with extensive knowledge of and familiarity with toolstone sources across the Plains (e.g., Miller in Frison 1991), using both macro-and microscopic methods.

[1] I also conducted an attribute analysis of the debitage, which is not described in this paper. Following Surovell (2003), I used a size cutoff of 1.5 cm (maximum flake dimension) for individual flake attribute analysis, and flakes <1.5 cm were analyzed in mass by nodule type. See Prasciunas (2008) for details of the attribute analysis.

Table 4.2. Summary of Sheaman site nodules by raw material, nodule type (MIN/SIN) and composition. Total numbers of flakes and tools contained in nodules are also provided, summed by raw material type.

Raw Material	Local?	Nodule Type	Composition	Number of Nodules
Mississippian chert	No	MIN	Debitage only	22
Total (flakes +tools)=3577		MIN	Debitage + tools	14
		SIN	Single flake	3
		SIN	Single tool	12
			Total	*51*
Mississippian porcellanite	No	MIN	Debitage only	1
Total (flakes)=13			*Total*	*1*
Cloverly/Morrison orthquartzite	No	MIN	Debitage only	3
Total (flakes +tools)=193		MIN	Debitage + tools	2
		SIN	Single flake	5
		SIN	Single tool	1
			Total	*11*
Knife River Flint	No	MIN	Debitage only	1
Total (flakes)=326			*Total*	*1*
Non-volcanic glass	No	SIN	Single flake	1
Total (flake)=1			*Total*	*1*
Playa lake chert	No	SIN	Single tool	1
Total (tool)=1			*Total*	*1*
Powder River Basin clinker	No	SIN	Single flake	1
Total (flake)=1			*Total*	*1*
Scenic chalcedony	No	MIN	Debitage + tools	1
Total (flakes +tools)=20			*Total*	*1*
Miocene chert	Yes	MIN	Debitage only	1
Total (flakes +tools)=508		MIN	Debitage + tools	1 (with core)
		SIN	Single flake	1
			Total	*3*
Miocene porcellanite	Yes	MIN	Debitage only	1
Total (flakes)=20			*Total*	*1*
Tongue River Silicified Sediment	Yes/No	MIN	Debitage only	6
Total (flakes)=252			*Total*	*6*
Plate chalcedony	Unknown	SIN	Single flake	1
Total=1			*Total*	*1*
Total Multiple Item Nodules (MIN)=53				
Total Single Item Nodules (SIN)=26				

Note: Does not include artifacts too small or too burned to nodualize.

Nonlocal Raw Material Types[2]

Mississippian Chert/Porcellanite: The majority of the nodules in the Sheaman assemblage were manufactured from nonlocal Mississippian chert (51 of 79 nodules, or 65%; Table 4.2). The likely source of this material is the Guernsey Formation of the Hartville Uplift, whose closest source lies roughly 80 kilometers southwest of the site. Of the nodules manufactured from Mississippian chert, most (36 of 51 nodules, or 71%) are multiple item nodules that contain debitage only or debitage and tools. The debitage in both types of MINs is overwhelmingly dominated by bifacial thinning flakes. All tools within Mississippian debitage + tool MINs are very lightly used biface thinning flakes, which represent expedient use of suitable flakes struck during biface reduction/production, rather than a tool meant to be part of the transported toolkit itself. Thus the Mississippian MINs containing debitage only and debitage + tools provide evidence of the number of bifaces that were reduced or produced from Mississippian chert on-site, and then removed to once again become part of the transported toolkit (n=36).

Fifteen of the Mississippian nodules are SINs. Three SINs contain flakes, and 12 contain tools (Table 4.2). Eleven of the tool-bearing SINs contain flake tools, and one contains the only Clovis point recovered at the site. The SINs containing flakes provide evidence of on-site tool resharpening, and indicate maintenance of bifaces and/or tools that were brought into the site and then removed to once again become part of the transported toolkit (n=3) (Table 4.1). The SIN tools represent items brought into the site that were not resharpened or maintained there, and that were then removed from the transported toolkit and discarded on-site. There are many more SIN tools of Mississippian chert than any other raw material type.

Only one nodule of Mississippian porcellanite is present in the assemblage (Table 4.2). It is a debitage only MIN that indicates on-site maintenance of a tool that was part of the transported toolkit.

Cloverly/Morrison Orthoquartzite: Cloverly/Morrison orthoquartzite nodules consist of five MINs (three debitage only and two debitage + tools) and six SINs (five flake only and one tool only nodule; Table 4.2). The likely source of this material is the Spanish Diggings quarry in the Hartville Uplift, 90-140 kilometers southwest of the site. Similar in structure to the Mississippian MINs, debitage in the debitage only orthoquartzite MINs and one of the debitage + tools nodules consists mostly of bifacial thinning flakes, and the flake tools in one of the debitage + tool MINs are very lightly and expediently used biface thinning flakes. These MINs, like the Mississippian MINs, therefore provide evidence of the number of bifaces that were reduced, produced, or maintained on-site, that were then removed to once again become part of the transported toolkit (n=4). The other debitage + tool MIN, however, contains a large bifacial thinning flake tool with few associated flakes, most of which are <1.5 cm, which may represent maintenance debris rather than evidence of on-site production of the tool (refits between the tool and flakes were not found, but only the proximal portion of the flake tool was recovered). This flake tool may be more like a SIN than a MIN in that it may have been transported into the site in very near its current form, where it was then possibly used and/or resharpened and discarded. Another alternative is that this flake tool was struck on-site from a biface that was subsequently removed, and the associated flakes represent part of the tool manufacturing debris.

The five orthoquartzite single item flake nodules indicate on-site maintenance or resharpening of tools manufactured off-site, that were then removed from the site and continued to be part of the transported toolkit (although in several cases these single flakes are fairly coarse-grained, and could represent spalls off of hammerstones or chopping tools rather than deliberate tool maintenance). The single orthoquartzite tool nodule contains a split cobble chopper.

[2] Nonlocal raw material is defined following Surovell [2003], as material acquired more than 20 km linear distance from the site, or the maximum distance a pedestrian forager could reasonably travel in one day.

Knife River Flint: One nodule of Knife River Flint is present in the assemblage. The sources area for Knife River Flint lies roughly 520 kilometers north and slightly east of the site. The nodule contains debitage only. It should be noted, however, that Knife River Flint is a very homogeneous material type and it may not be possible to separate into MANs. Additionally, much of the Knife River Flint in the assemblage was burned, which would have made identification of distinct nodules, if present, even more difficult. In any case, the presence of debitage only indicates on-site production and/or maintenance of an item (or items) that was then removed from the site. If more than one nodule is actually represented by the debitage in the debitage only MIN, then more than one item was produced or resharpened and removed from the site. Once again, debitage is dominated by bifacial thinning flakes.

Nonvolcanic Glass/Playa Lake Chert/Powder River Basin Clinker: Nonvolcanic glass from the northern Powder River Basin roughly 175 kilometers north of the site and Powder River Basin clinker are represented by single artifacts. Both of these nodules are single item flake nodules (Table 4.2). This indicates that tools of these material types entered the site already manufactured, were resharpened/maintained at the site, and again removed to remain part of the transported toolkit. Playa lake chert, whose source area lies at least 300 kilometers from the site, is also represented by only one artifact, but in this case is a small (<1.5 cm), heavily burned flake tool fragment. The nodule is therefore a single item tool nodule. This nodule represents a tool that was brought into the site in finished form and discarded without maintenance, possibly because it was exhausted.

Scenic Chalcedony: On MIN of Scenic Chalcedony is present in the assemblage. The source area of White River Group Scenic chalcedony lies east of the Black Hills roughly 145 kilometers from the site. The nodule contains mostly small (<1.5 cm) flakes, and two flake tools, and represents on-site production, use and/or maintenance, and discard.

Tongue River Silicified Sediment: One debitage only MIN of Tongue River Silicified Sediment is a nonlocal variety known from the Powder River Basin of northern Wyoming, roughly 175 kilometers from the site. This nodule indicates on-site production or maintenance of a tool that was subsequently removed from the site.

Local Raw Material Types

Miocene Chert/Porcellanite: Miocene chert is present in the form of two MINs and one SIN. Most of the material is clearly of local origin. The source of the debitage only MIN, however, is unclear. This nodule contains bifacial thinning flakes and represents on-site production of a biface that was then removed. The other MIN contains the local Moss Agate material, and consists of core reduction debitage along with the reduced core itself. This is the only core present in the assemblage, and along with its associated reduction debris (none of which appear to have been utilized) represents on-site reduction or testing of local raw material that was then rejected, possibly because of non-ideal flaking properties. The SIN contains one small (<1.5 cm) flake. Rather than representing on-site tool resharpening or maintenance as suggested by Table 5.1, however, this small flake fragment (lacking a platform) is coarser grained than the other Miocene chert nodules, and may represent a spall from a grade of Miocene chert used for a hammer or chopping tool, rather than a deliberate flake. The nodule of local Miocene porcellanite, similar to that of the local Moss Agate nodule, contains unutilized core reduction flakes. Although the core itself was not recovered, it is unlikely it was removed from the site.

Tongue River Silicified Sediment: Five of the six debitage only MINs of Tongue River Silicified Sediment consist of the locally available coarse-grained variety, and are most likely spalls from hammer or chopping tools rather than deliberate flakes, although they could represent resharpening flakes from heavy duty tools like choppers.

Raw Material of Unknown Origin

Plate Chalcedony: Plate chalcedony of unknown origin is represented by a single artifact, and is a single item flake nodule. This indicates that a tool of this material type entered the site already manufactured, was resharpened/maintained at the site, and again removed to remain part of the transported toolkit.

INTERPRETING NODULE COMPOSITION

Returning to the question of whether the Sheaman assemblage fulfills the predictions of the high-tech forager model, it is useful to translate the model's technological and behavioral expectations into archaeological terms. If Clovis populations were highly mobile big-game hunters that ranged over extremely large territories, we would expect nonlocal raw materials to be present within the assemblage. In the context of an unknown or incompletely known landscape, we would also expect the presence of nonlocal, high quality raw materials to reduce the risk of not encountering local raw materials of high enough quality to fulfill technological needs. Highly mobile foragers should also conserve raw material as a response to inconsistent access to high quality toolstone. Such conservation should be apparent in a highly curated toolkit in which the use-lives of tools are extended through maintenance, resharpening, and recycling into different tool forms. A heavy reliance on bifacial core technology is also a fundamental component of the model, and should be obvious by the presence of bifaces themselves and/or bifacial reduction debris. If bifaces were used first as cores and then as blanks for tools, then many flake tools should be manufactured on flakes struck from bifaces, and amorphous cores and core reduction debris should be very rare or absent.

We would also expect to see evidence of a tool replacement strategy appropriate for foragers exploiting resources within the context of an unknown or incompletely known landscape. What might such a tool replacement strategy look like? Kuhn's (1989) model of tool replacement, based on Binford's (1980) forager-collector dichotomy, argues that mobility will affect how and when people choose to replace tools. In this model, collectors, characterized by high rates of logistical mobility, should replace tools all at once and in advance of exhaustion. This will reduce the risk of equipment failure and ensure that they are not without the proper equipment when it is needed away from camp. Foragers, characterized by high rates of residential mobility, should replace tools gradually as they become exhausted.

Replacement of all tools at once or a "gearing up" strategy (Binford 1977, 1978) means that tools are produced in anticipation of use, and that tool needs are to some extent known. It ensures that tools will be available in the future, when time for manufacture may be limited. Gearing up activities are likely to take place in residential camps during periods of free time (Binford 1978; Kuhn 1989:34). This strategy requires the availability of enough raw material to satisfy tool manufacture needs, and so necessitates either moving the entire group to the quarry for some amount of time (as described by Reher [1991] for the Spanish Diggings quarries), or sending small logistical parties to the quarry to either manufacture tools on the spot, or bring material for tool manufacture back to camp. Gearing up allows the toolkit to sustain periods of stress, accommodating tool needs until the next gearing up event. Thus gearing up might occur when critical resources such as food and raw material are not expected to overlap for some amount of time (Binford 1980:10; Sellet 1999:58).

In contrast, if food and lithic resources are known to overlap, and thus future access to raw material is secure, tools will likely be replaced progressively as needed and as raw material becomes available. This strategy requires less raw material at a single point in time than gearing up, and does not necessitate specialized trips to raw material localities. With such a gradual tool replacement, raw material acquisition was likely embedded in subsistence activities (Binford 1979:259; 1980).

The forager method of gradual tool replacement requires that raw material availability can be accurately anticipated, and would therefore be most appropriate in the context of a known landscape. The high-tech forager model would therefore predict a gearing up, rather than gradual, tool replacement strategy, which would allow the toolkit to sustain periods of stress. Archaeological evidence of a gearing up strategy might include discarded tools, possibly completely exhausted depending on time elapsed since the last gearing up event, as well as evidence of tool manufacturing activities. The tools manufactured on-site should not be present, as they would have been removed to become part of the transported toolkit. Tools manufactured on-site should be larger than those discarded there, and tools should be manufactured from the same raw material. Alternatively, with a more gradual tool replacement strategy, the components of the toolkit remain constant through time, with every exhausted tool replaced by a new equivalent one as they are discarded. The types of raw materials present should be more variable because they were acquired through an embedded procurement strategy. Discarded tools may not be much smaller than those manufactured, should have less evidence of intensive use and conservation through reworking/recycling, and numbers of tools discarded at the site should be similar to the numbers of tools manufactured (Sellet 1999:59-61).

With the above expectations developed, we can now use MANA to test the degree to which the Sheaman assemblage fulfills the predictions of the high-tech forager model.

Raw Material Use

The Sheaman site flaked stone assemblage is overwhelmingly dominated by nonlocal raw material, which makes up roughly 98% of the entire assemblage (Table 4.3; see Prasciunas 2008). This is particularly interesting considering that knappable quality chert and porcellanite do occur in the immediate site area as lag deposits. For instance, at the Folsom component at Area 2 of the Agate Basin site, only about 650 meters southwest of Sheaman (see Figure 4.1), 41 percent of the total artifact assemblage is manufactured from local raw material (Surovell 2003). The presence of channel flakes, flake tools, and bifaces manufactured from local raw material in the Agate Basin assemblage (Surovell 2003) demonstrates that at least some locally available raw material was indeed of high enough quality to manufacture Folsom points and/or other tools, and begs the question why so very little local raw material is present at Sheaman. With its extreme emphasis on non-local raw material, representing distances traveled of up to 520 kilometers (see nodule descriptions above), the Sheaman site certainly conforms to the raw material use expectations of the high-tech forager model.

Table 4.3. Counts of local and nonlocal raw material from the Sheaman site by artifact class (unknown material excluded).

Artifact Type	Local Material	*Nonlocal Material	*Sum*
Debitage	103	4285	4388
Flake Tools	0	64	64
Cores	1	0	1
Bifaces	0	2	2
Channel Flakes	0	1+	1+
Projectile Points	0	1	1
Sum	104	4353	4457
Percent	2.33%	97.67%	

*Nonlocal raw material is defined following Surovell [2003], as material acquired more than 20 km linear distance from the site.

Tool Conservation

Few tools were discarded at the Sheaman site, and it is therefore difficult to evaluate the degree to which tools were utilized and conserved. The majority of the recovered SIN tools, however, were not heavily reworked or exhausted, and the toolkit in general was not under stress as evidenced by an abundance of tool manufacturing debris. Conservation of raw material as a response to inconsistent access to high quality toolstone is therefore a prediction of the high-tech forager model that is not fulfilled by the Sheaman assemblage. However, whether or not evidence of tool conservation is apparent at a particular site will depend on strategies of tool replacement and the site's role in the acquisition and exploitation of raw material (e.g., Ingbar 1994). Because of its relationship to tool replacement strategies, evidence of tool conservation is discussed further under *Tool Replacement Strategy* below.

Reliance on Bifacial Core Technology

Only two bifaces are present in the entire flaked stone assemblage (Table 4.3). If the presence of bifaces is used as a measure of reliance on bifacial technology, we would conclude that very little biface manufacture and/or reduction occurred at the site, and thus that its occupants did not rely heavily on bifaces. The debitage, however, tells another story. Approximately 86% of the debitage from Sheaman subjected to an attribute analysis consists of clearly identifiable bifacial thinning flakes[3] , indicating that even if bifaces were not recovered, they were certainly manufactured and/or reduced at the site.

Even knowing this, though, it is still not possible to know exactly what the counts of bifacial thinning flakes mean in terms of numbers of bifaces that were actually reduced or manufactured at the site. Because so much of the assemblage was manufactured from the same raw material type (Mississippian chert), an argument could be made that most of the bifacial thinning flakes at the site represent debris from only one biface reduction/manufacturing episode. Simple counts could therefore overemphasize the amount of bifacial reduction that actually occurred at the site. MANA provides a better way to evaluate the respective importance of reduction technique than simple artifact count, because the number of nodules is independent of reduction intensity.

More than 40 debitage only/debitage + expedient tool minimum analytical nodules dominated by bifacial thinning flakes were identified in the Sheaman assemblage, indicating that at least that many bifaces passed through the site. The relative absence of core reduction, and the total absence of core reduction on nonlocal raw material, indicates that Clovis groups transported only bifaces and flake tools, and relied on bifaces as cores for sources of expedient flake tools to satisfy on-site tool needs. There is no evidence that cores were transported, as suggested by Bamforth and Becker (2000) for later Paleoindian sites.

Even if cores have a small probability of discard in sites with short occupation spans because they are long use-life tools, as argued by Bamforth and Becker (2000), we still might expect to see core reduction debris manufactured from nonlocal raw material, if not the cores themselves. At Sheaman, the only evidence of core reduction comes from local raw material, and it is extremely limited. Kuhn (1994:435) and Surovell (2003:225) have shown that the transport efficiency of carrying tool blanks exceeds the transport efficiency of carrying cores. If transport efficiency is a major factor influencing toolkit design, then cores should not be transported between sites (Surovell 2003:224). The evidence from Sheaman suggests that cores were not a part of the mobile toolkit, and that transport efficiency was a major factor influencing toolkit design. Surovell (2003:220), following Kuhn (1994) also suggests that transported tools should be manufactured from bifacial thinning flakes to maximize transport efficiency. SIN tools from Sheaman, or those items that were transported as tools into the site, were manufactured predominantly on bifacial thinning flakes, providing further evidence for the transport efficiency of the mobile toolkit.

In sum, the heavy reliance on bifacial technology evident at Sheaman, coupled with the use of bifaces as cores and the overall transport efficiency of the mobile toolkit, fulfill the expectations of the high-tech forager model.

Tool Replacement Strategy

An examination of flake size provides a better understanding of what the MINs and SINs in the assemblage actually represent in terms of biface reduction/production or tool maintenance activities. Within the context of specific nodules, flake size can provide an indication of reduction stage. For instance, if a nodule consists of only a few small pressure flakes, it is likely that it represents tool maintenance rather than earlier stage biface reduction. As noted above, I used a

[3] The attribute analysis (including flakes >1.5 cm) identified 676 bifacial thinning flakes versus 106 core reduction flakes in the Sheaman assemblage. 693 flakes were classified as indeterminate and are excluded from the above frequency calculation (see Prasciunas 2008).

size cutoff of 1.5 cm (maximum flake dimension) for individual flake attribute analysis, and flakes <1.5 cm were analyzed in mass by nodule type (see Prasciunas 2008). Flakes <1.5 cm therefore were not identified in terms of flake type, and I assume for this discussion that while small flakes certainly can be produced during early stage biface reduction, their presence and abundance nonetheless provides a reasonable indication of early versus late stage tool production.

Table 4.4 shows numbers of debitage bearing nodules (single flake, debitage only, and debitage + tools) by raw material type and flake size. Debitage bearing nodules manufactured from Mississippian chert contain many flakes that are both greater and less than 1.5 cm, as well as nodules containing only small flakes (<1.5 cm) and only large flakes (>1.5 cm) (Table 4.4). This suggests that different stages of bifacial reduction occurred at the site, an interpretation supported by refitting studies (Frison and Stanford 1982). In some cases, nodules of Mississippian chert were completely reduced from fairly early stages to finished bifacial tool forms (those nodules containing abundant flakes both > and < 1.5 cm), in other cases bifaces were only partially reduced and left in an early stage form (those nodules containing only flakes >1.5 cm), and in still other cases late stage bifaces were reduced to a final or nearly final bifacial tool form (those nodules containing only flakes <1.5 cm), such as a projectile point. The presence of at least one channel flake in the assemblage (Frison and Stanford 1982:153) supports the suggestion of projectile point manufacture (Table 4.3).

Leaving aside flakes <1.5 cm and only considering flakes >1.5 cm, an analysis of variance using flake mass as a proxy for overall flake size indicates significant differences in flake size among the different nodules of Mississippian chert ($F=1.82$, $df=25$, $p=.009$ [a Kruskal Wallis test also yields a p-value of .009]). This means that even when only flakes >1.5 cm are considered, it is still clear that different stages of bifacial reduction occurred at the site, or at least that bifaces of different sizes were reduced/produced on-site from the same raw material type.

This same on-site staged manufacture is not apparent with other nonlocal debitage bearing nodules, probably because they were manufactured from raw material acquired further from the site, and had thus been subjected to more intensive utilization. For instance, other nonlocal debitage bearing nodules tend to consist mostly of later stage tool production debris (or debris that is mostly <1.5 cm), such as the nodules of Mississippian porcellanite, Knife River Flint, Miocene porcellanite, and Scenic chalcedony (Table 4.4).

Table 4.4. Numbers of debitage-bearing nodules at the Sheaman site by raw material and debitage size.

	Debitage			Comments
Raw Material	*only >1.5 cm*	*only <1.5 cm*	*both*	
Mississippian chert	4	8	27	
Mississippian porcellanite	0	0	1	mostly <1.5 cm
Cloverly/Morrison orthoquartzite	0	7	3	
Playa lake chert	0	0	0	
Non-volcanic glass	0	1	0	
Plate chalcedony	0	1	0	
Powder River Basin Clinker	1	0	0	
Knife River Flint	0	0	1	mostly <1.5 cm
Miocene chert	0	1	2	
Miocene porcellanite	0	0	1	mostly <1.5 cm
Scenic chalcedony	0	0	1	mostly <1.5 cm
Tongue River Silicified Sediment	0	1	5	
Sum	5	19	40	

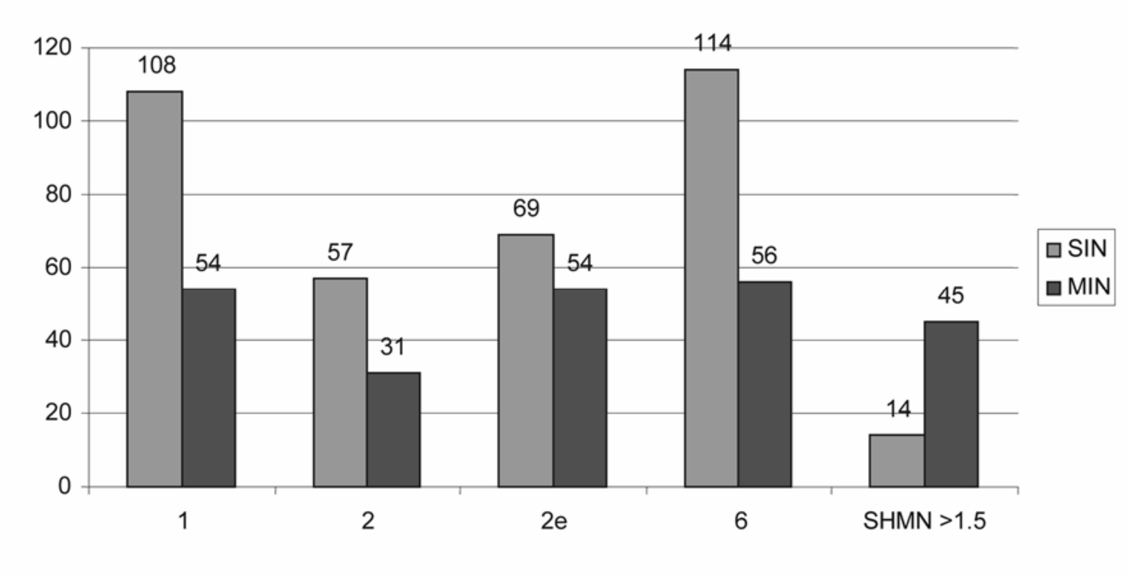


Figure 4.2. Counts of Single Item Nodules (SIN) and Multiple Item Nodules (MIN) from levels 1, 2, 2e, and 6 from the Hell Gap site (from Sellet 1999:196; Figure 112) and from the Sheaman site (only including flakes >1.5 cm).

The flake size data, then, suggest that most nonlocal raw material types were introduced into the site as prepared bifaces, either in late stages of reduction that were then finished or nearly finished on-site, or as finished tools that were then maintained or resharpened. Nodules of Mississippian chert, however, provide evidence that both early and late stage bifaces were brought into the site, some of which were left in early stages when the occupants departed, and some of which were reduced to finished or nearly finished tools. Even nodules of Mississippian chert, however, generally lack cortex, indicating that the raw material procurement locality was far enough away from the Sheaman site to make field processing economical (Metcalf and Barlow 1992). The overwhelming dominance of Mississippian chert in the assemblage, coupled with the fact that some Mississippian nodules appear to represent fairly early stages of biface reduction, suggest that the Sheaman site was one of the first stops since visiting the raw material procurement locality.

A Comparative Sample. To better understand what the nodules identified at the Sheaman site can tell us about the tool replacement strategies of the site's occupants, it is useful to have a comparative sample. Sellet (1999) conducted a Minimum Analytical Nodule Analysis of the flaked stone assemblage recovered from four Paleoindian levels at the Hell Gap site in eastern Wyoming, roughly 160 kilometers southwest of the Sheaman site. The Hell Gap site, which contains a stratified record of Paleoindian occupation spanning 2,000 years (Larson et al. 2009), is located on the Hartville Uplift, a source of the same high quality Mississippian chert as that present in the Sheaman assemblage. Sellet's MANA and reconstruction of technological activities from Paleoindian levels 1, 2, 2e and 6 from Locality 1 at the Hell Gap site provides a comparative sample against which to evaluate and interpret nodule composition at the Sheaman site.[4]

[4] Although Sellet (2004) also conducted a MANA of tools and debitage from Area 2 of the Agate Basin site, this analysis was aimed at quantifying projectile point manufacture, and is therefore not as relevant to understanding Sheaman nodules as his more comprehensive MANA undertaken at the Hell Gap site.

Table 4.5. Chi-square values and probabilities for counts of MINs and SINs from Hell Gap Locality 1 levels (from Sellet 1999:196) and the Sheaman site. Counts shown in Figure 4.2.

	Hell Gap level 1	Hell Gap level 2	Hell Gap level 2e	Hell Gap level 6
Sheaman	x^2=32.24, p<.001	x^2=23.83, p<.001	x^2=6.84, p<.001	x^2=33.36, p<.001
Hell Gap Level 1		x^2=.09, p=.76	x^2=3.32, p=.07	x^2=.01, p=.94
Hell Gap Level 2			x^2=1.61, p=.21	x^2=.14, p=.71
Hell Gap Level 2e				x^2=3.66, p= .06

Figure 4.2 above shows counts of SINs and MINs from Hell Gap by level (from Sellet 1999:196; Figure 112) and the Sheaman site. To be comparable to Sellet's analysis, only nodules that contain flakes >1.5 cm are included. While counts of SINs appear to be related to counts of MINs at Hell Gap (i.e., the more SINs present, the more MINs present), Sheaman appears to have fewer SINs than expected based on numbers of MINs. Chi-square tests indicate that Sheaman does indeed have significantly fewer SINs and more MINs than expected compared to every level at Hell Gap (Table 4.5). In contrast, there are no significant differences between counts of SINs and MINs between levels at Hell Gap.

This suggests that unlike at Hell Gap, significantly more tools were manufactured at Sheaman and then removed (measured by counts of MINs) than were left behind at the site (measured by numbers of SINs). This strong emphasis on manufacturing activities is consistent with some type of gearing up strategy (Binford 1978), rather than with gradual tool replacement. A strategy of gearing up is especially evident considering that most of the SINs >1.5 cm at Sheaman are flake tools and nearly all of the MINs at Sheaman represent bifacial reduction/production. In other words, even though biface manufacture was the primary activity that occurred at the site, no discarded or rejected bifaces were left behind.

Another informative comparison is between the types and frequencies of nodules present at Hell Gap and those present at Sheaman. As discussed above, Sellet's (1999:61-70) scenarios of raw material procurement, use, and discard provide a useful baseline from which to interpret nodule composition. For his MANA of debitage recovered from Hell Gap Locality 1, Sellet (1999:69-71)

Table 4.6. Relationship between Sellet's nodule categories (1999:69-71) and procurement and exploitation scenarios (1999:62-69). Arrows note correspondence between categories and scenarios.

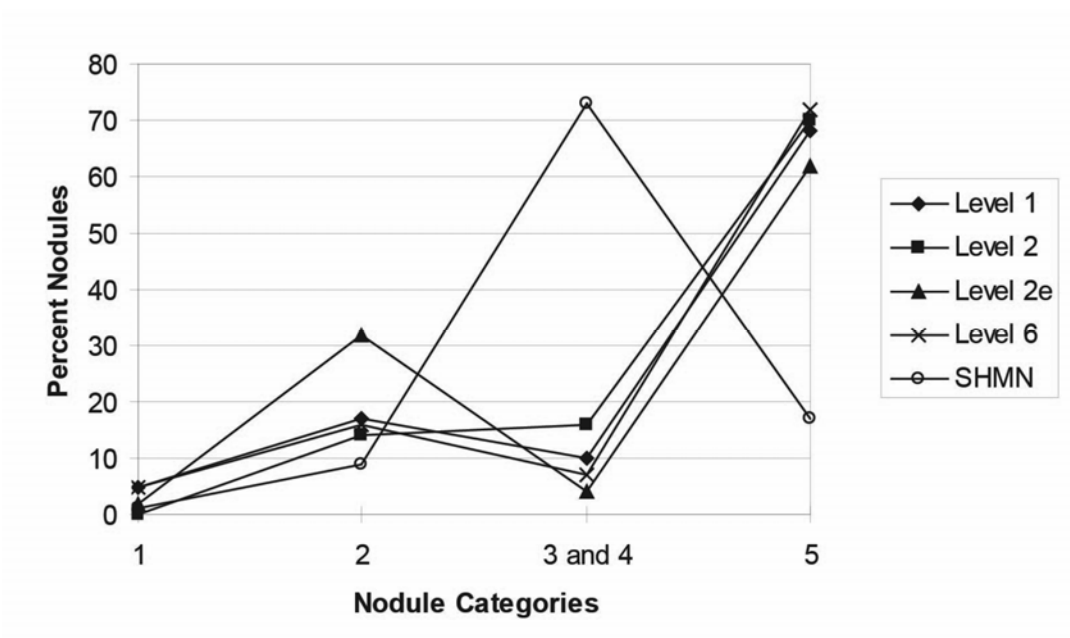
Acquisition	Exploitation	Discard	Nodule Categories		Exploitation Scenarios	Description
On site	On site	On site	1	→	2	Local material used and discarded expediently
On site	On/Off site	Off site	2	→	3	Local material used on/off site, removed from site
Off site	On/Off site	On site	3	→	4	Nonlocal material used on/off site, not removed from site
Off site	On/Off site	Off site	4	→	6	Nonlocal material used on/off site, removed from site
Off site	On/Off site	On site	5	→	4/5	Nonlocal material used on/off site, not removed (e.g., finished tools)

distinguished five categories of nodules, each of which relates to one or more of his seven scenarios of lithic acquisition and exploitation (described above; see Table 4.6 above for summary).

Category 1 refers to raw material that was acquired, exploited, and discarded on-site (Sellet's [1999:64] Scenario 2), in other words, local raw material that was expediently used and discarded. Category 2 refers to raw material that was acquired on-site, exploited both on and off-site, and then removed from the site (Sellet's Scenario 3). Category 3 refers to raw material acquired off-site, exploited off- and on-site, and discarded on-site (the bifaces or cores of Sellet's Scenario 4). Category 4 refers to raw material that was acquired off-site, exploited off- and on-site, and then again removed from the site and discarded off-site (Sellet's Scenario 6). Finally, Category 5 refers to material acquired off-site, exploited on and/or off-site, and discarded on-site (the finished tools described in Sellet's Scenarios 4 and 5).

Figure 4.3 shows the percentage of nodule categories in levels 1, 2, 2e, and 6 at Hell Gap Locality 1 (from Sellet 1999:236) and the Sheaman site (Sellet grouped Categories 3 and 4 together because small numbers of artifacts made these nodules difficult to differentiate [Sellet 1999:234-235]). Although certain technological differences are apparent between levels at Hell Gap, there is also an underlying unity in terms of the structure of the transported toolkit. For instance, all levels are dominated by nodules containing finished tools of nonlocal material (Category 5). The next most abundant nodules in general contain local material and lack finished tools (Category 2). Nodules containing evidence of expedient manufacture, use, and discard of local raw material (Category 1) are barely represented. This means that in all levels at Hell Gap examined by Sellet, many more tools were discarded on-site than were manufactured there. In contrast, the percentages of nodule categories present at the Sheaman site exhibit a distinctly different pattern (Figure 45.3). Although similar to Hell Gap in terms of having a very low percentage of nodules containing evidence of expedient manufacture, use, and discard (Category 1), Sheaman site nodules are overwhelmingly dominated by nonlocal biface production/reduction debris, without associated

Figure 4.3. Percentage of nodule categories in levels 1, 2, 2e, and 6 at Hell Gap Locality 1 (from Sellet 1999:236; Figure 149) and the Sheaman site.



bifaces (Category 3/4). Also in contrast to Hell Gap, relatively few nonlocal finished tool nodules (Category 5) are present at Sheaman. This means that, unlike at Hell Gap, many more tools were manufactured on-site at Sheaman than were discarded there.

Also unique to Sheaman is the very low percentage of nodules containing evidence of expedient tool manufacture and transport (Category 2) relative to nonlocal biface production/reduction nodules (Category 3/4). This percentage is likely even lower than that shown in Figure 5.3 because Figure 5.3 includes nodules of local raw material that may represent spall from hammerstones or choppers rather than deliberate tool manufacture. Both categories 2 and 3/4 indicate on-site manufacture of items that were then removed to become part of the transported toolkit, but Category 2 involves local raw material while Category 3/4 involves nonlocal material. The dominance of Category 3/4 indicates reliance at Sheaman on tools (bifaces) that were already in the system, rather than tools that were manufactured on the spot from local raw material. The levels at Hell Gap typify a gearing up strategy that might be expected at a quarry site, where tools are discarded all at once, and the toolkit is refurbished from local raw material at the same time (categories 2 and 5; Sellet 1999:65-67). This makes sense considering that the area immediately surrounding Hell Gap contains abundant high quality raw material (Miller 1991).

Discussion. The comparison of Sheaman and Hell Gap nodule types raises several questions. First, why are there so few finished nonlocal tool nodules (Category 5) at Sheaman compared to Hell Gap? Second, why are there so many more nonlocal tool manufacturing nodules (Category 3/4) at Sheaman compared to Hell Gap? Third, why did the occupants of Sheaman choose to manufacture so many tools at the Sheaman site (as evidenced by the extreme abundance of Category 3/4 nodules at the site) rather than at the quarry, which would have minimized the carrying costs associated with transporting the toolkit? A consideration of site location/function may help answer the first two questions. Unlike Hell Gap, Sheaman is not located at the raw material procurement locality. The occupants of Sheaman may have discarded their tools in need of replacement closer to the quarry from which they obtained their high quality Mississippian chert, knowing that they now had sufficient raw material to replace them. When they reached Sheaman, they would have had few tools left to discard. If this was the case, then we would not expect to find evidence of toolkit stress in the form of exhausted and heavily reworked tools at the Sheaman site itself. However, the SIN flake tools that were discarded at Sheaman are for the most part large, and do not appear to be exhausted. Why would these tools be left behind? Although these items are SINs and so were not manufactured on-site, they are all manufactured from Mississippian chert and so had likely not been part of the transported toolkit for long. Possibly their discard at Sheaman represents the assembly of an optimal toolkit following gearing up, when raw material availability was not an issue.

If Clovis groups did not know when or where they would next encounter suitable raw material, it seems likely they would take advantage of opportunities to acquire high quality raw material, possibly replacing large components of their toolkits all at once. Therefore, the high-tech forager expectation of finding tools that are exhausted and heavily reworked might not be reasonable at all sites (such as those immediately following a gearing up event), even if Clovis foragers did at times intensively utilize the raw material they transported. To ensure tool availability in an unfamiliar landscape where future events are unknown, Clovis tool replacement may have followed more of a collector strategy, with tools at times being heavily reworked, but at other times replaced well in advance of exhaustion. In this regard, Clovis foragers might be considered “high-tech collectors” rather than “high-tech foragers”.

However, it is important to remember that the forager-collector dichotomy and associated tool replacement strategies are not, and were never meant to be, mutually exclusive (Binford 1980:12; Kelly 1983: 301; Sellet 2004:1561). In particular, (and as argued by Kelly and Todd [1988]), the landscape use, settlement strategies, and technological organization of Clovis colonizers may exhibit unique combinations of collector and forager traits for which there are no analogs. For instance, while Kuhn's (1989) tool replacement model links gearing up with collectors, who are in turn characterized by high rates of logistical versus residential mobility, Clovis foragers may very well have had high rates of residential mobility while still choosing to gear up. Shott (1986) has shown a negative correlation between the number of residential moves per year and toolkit diversity, arguing that as residential mobility increases, tools become more multifunctional and less specialized. The Sheaman toolkit, then, overwhelmingly dominated by bifaces at various stages of reduction, supports the high tech forager assumption of high rates of residential mobility while exhibiting a tool replacement strategy generally associated with collectors. The tool replacement strategy of the occupants of Sheaman appears to contain a unique combination of collector (gearing up) and forager (gearing up with generalized, functionally nonspecific, tool forms [i.e., bifaces]) characteristics.

The final question is why so much tool manufacture (i.e., gearing up) would have occurred at the Sheaman site rather than at the quarry itself, which would have minimized the costs associated with transporting the toolkit. Larson and Kornfeld (1997) discuss two important variables conditioning nodule composition: amount of time available for tool manufacture and predictability of future events (Torrence 1983). Amount of time available refers to either duration of occupation or amount of time allotted for tool manufacture. Nodule composition can be predicted based on different relationships between time available and event predictability (Larson and Kornfeld 1997:13-14). For instance, if production activities are not constrained by time and tool needs are known (because future events are known), we would expect MANs to contain the complete production sequences of specific tools without the tools themselves, which would have been transported off-site. If duration of occupation was long (rather than just abundant time allotted for manufacture), we might also expect some MANs to contain evidence of expedient tool manufacture, use, and discard.

At Sheaman, although duration of occupation does not appear to have been long (based on the virtual absence of expediently manufactured, used, and discarded tools), there was certainly abundant time allotted for tool manufacture. Perhaps time was a limiting factor at the quarry, so rather than manufacture tools there, even though doing so would decrease carrying costs, the occupants of Sheaman carried raw material in various stages of production until time allowed them to more completely replenish their toolkits. If Sheaman is a camp associated with a kill, which seems likely considering its proximity to other Paleoindian killsites in the same arroyo system (Frison and Stanford 1982) and the presence of bison bone at the site, perhaps time for tool manufacture was available either before or after the kill.

A consideration of site function, time, and predictability of future events provides a better understanding of why tool manufacture at Sheaman may have occurred when and where it did, and why the nodule constituents from Sheaman and Hell Gap differ. Even though Hell Gap is located at the raw material procurement locality and Sheaman is not, the technological organization represented by the two sites appears fundamentally different. Even if we excavated the raw material procurement locality where the occupants of Sheaman obtained their Mississippian toolstone, unlike at Hell Gap we would likely find little evidence of tool manufacture there. Based on the extreme abundance of biface reduction/production nodules of Mississippian chert in the Sheaman site assemblage, the occupants of Sheaman appear to have geared up on-site rather than at the quarry. Perhaps time for the occupants of Sheaman was limited at the raw material procurement locality in a way that it was not for the occupants of Hell Gap. Although speculative, this may mean that locations on the landscape such as the Hell Gap valley, that were productive in terms of diverse food resources, fuel, water, and high quality raw material (Sellet 1999:18) (all of which would be necessary for any kind of long term camp), were unknown to Clovis groups[5]. Perhaps the occupants of Sheaman procured their Mississippian chert at a locality unsuitable for a stay of any duration, and so may have moved on without taking the time to replenish their toolkits there.

Summary. In sum, the tool replacement strategy employed by the occupants of Sheaman was one of gearing up, rather than gradual tool replacement. A gearing up strategy would be expected in the context of an unknown lithic landscape, when the availability of raw material cannot be accurately anticipated. The tool replacement strategy evident at Sheaman therefore fulfills the expectations of the high-tech forager model. The manufacture of generalized bifacial tools at various stages of production, rather than specialized and finished tool forms, also suggests that tool manufacture was designed to satisfy needs that were not entirely predictable, and therefore provides further support for the high-tech forager model.

CONCLUSION

This study examined the Sheaman site lithic assemblage using Minimum Analytical Nodule Analysis to test the utility of the high-tech forager model for explaining Clovis technological organization. The Sheaman assemblage fulfills many of the predictions of the high-tech forager model, and supports a traditional interpretation of Clovis technological organization. Exhausted, heavily curated tools, however, were not recovered at Sheaman. The toolkit was clearly not under stress, as evidenced by the presence of abundant manufacturing debris and tools discarded prior to exhaustion. Thus, the assemblage did not fulfill the high-tech forager model's prediction of raw material conservation. MANA helped explain this apparent contradiction, and allowed a more detailed picture of the technological decisions made by the occupants of Sheaman to emerge. The degree to which tools are utilized, maintained, or recycled will depend on strategies of tool replacement, as well as where one is sampling within a group's cycle of tool replacement. We should therefore not always expect to find evidence of the raw material conservation predicted by the high-tech forager model, even if such conservation occurred.

The Sheaman assemblage provides evidence of a "gearing up" type of tool replacement strategy, where many tools (mostly bifaces) were manufactured at the same time immediately following a visit to a raw material procurement locality. Few tools were discarded at Sheaman compared to the number of tools manufactured there, possibly because they were discarded at or near the raw material procurement locality, or possibly because Sheaman represents a very short occupation. While there is little evidence of conservation of the raw material type just acquired, the tools that made up the transported toolkit prior to arrival at the raw material procurement locality may or not have been heavily reworked or recycled prior to discard. The tool replacement strategy apparent at Sheaman differs from that of the Paleoindian levels at Hell Gap, and suggests that the occupants of Sheaman used the landscape in a different way than some of its later occupants.

In sum, while many post-Clovis Paleoindian sites may not conform to the expectations of the high-tech forager model (Bamforth 2002), the Sheaman Clovis site does. The strategy of technological organization evident at Sheaman includes a unique combination of collector and forager traits that might be expected among the earliest occupants of a region who possessed incomplete knowledge of the landscape. However, while the Sheaman assemblage does not falsify the predictions of the high-tech forager hypothesis, additional assemblage level tests of many more Clovis sites are necessary to

[5] Although the Hell Gap site provides a nearly complete chronostratigraphic record of High Plains Paleoindian cultural complexes, the best evidence of a Clovis presence in the valley comes from a single Clovis point fragment recovered from a surface context (Larson et al. 2009). The lack of a clear Clovis occupation at the site is a topic of current research (Larson et al. 2009).

determine whether the patterns identified at Sheaman are site specific, or are characteristic of Clovis in general.

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